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Income Diversification In Fishing And Aquaculture In The Tam Giang Lagoon – Adaptation To Climate Change Or Not?

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SLU

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ABSTRACT

Adaptation is strongly recognized as a means to cope with the impact and threat from climate change. The capacity which people use to make an adequate living for themselves determines how people respond to climate change. A better understanding of processes of adaptation is important to inform policies aimed at reducing the negative effects of climate change. Using qualitative interviews, including focus group discussion and in-depth interviewing, as main methods this research examines the heterogeneous nature of adaptation to climate change of the fishers and aquaculturalists in the Tam Giang lagoon and identifies the factors that prevent them from adaptation by focusing on income diversification. The results show that income diversification is used to respond to the impacts of not only climate but also non-climate stimuli. The absence of local labor markets, unfavorable climate conditions and animal epidemics prevent both fishers as well as aquaculturalists from income diversification. The qualification of income diversification as an adaptation process depends much on specific context of rural livelihoods. While income diversification can be considered as adaptation process in the case of aquaculturalists, it is considered as maladaptation process in case of the fishers. Local prejudice, low education, unskilled labor and inability to access agricultural land are the important factors impeding the fishers' adaptation process. Bases on this analysis the thesis concludes that (1) adaptation should be defined as a *successful and sustainable* adjustment to alleviate the negative impacts of change; (2) the interrelation between climatic and non-climatic factors needs to be addressed in policies aimed at mitigating the negative effects of climate change.

Key works: Climate change, adaptation, flood, fishers and aquaculturalists

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Tong Thi Hai Hanh,

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CONTENTS

LIST OF ABBREVIATIONS

CRS	Catholic Relief Services
IMHEN	Institute of Meteorological, Hydrological and Environment
IMO	International Organization for Migration
IMOLA	Integrated management of lagoon activities
IPCC	Intergovernmental Panel on Climate Change
MARD	Ministry of Agricultural and Rural Development of Vietnam
MOLISA	Ministry of Labour, Invalids and Social Affairs
NAV	Nordic Assistance to Vietnam
NCAP	The Netherlands Climate Assistance Program
NGOs	Non-government Organizations
USAID	U.S.Agency for International Development
VND	1 USD = 19.000 VND

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CHAPTER 1: INTRODUCTION

1.1. Problem statement

Climate is both a significant resource for human activities as well as significant hazard (Smit *et al.*, 2001). Currently, this balance between resource and hazard is changing due to the impact of industrialized society on the climate. The increased variability in temperature and precipitation coupled with the escalation of storms, floods and droughts in terms of intensity, frequency and abnormality in recent years, are the expressions of these changes.

Unforeseen and abrupt climate changes form crucial threats for human development, since they result in significant losses in terms of lives and assets. According to Downing *et al*. (1996a; 1996b as quoted in (Tol *et al.*, 2004) climate change can cause losses of up to 40% of the world GDP. Around 12 thousand people died and over 153 million people were impacted all over the world in 2005 due to wind storms, floods, droughts and temperature extremes (EM-DAT, 2005 quoted in (Lynch *et al.*, 2008). In addition to these losses is the decline in both productivity and quality of natural-based production activities such as agriculture, fisheries and aquaculture which can impoverish and marginalize rural livelihoods.

To sustain rural livelihoods now and in the future requires analysis of the impact of climate change issues on rural development. According to Tol *et al.* (1998), climates will change abruptly the coming time, which makes the search for ways to reduce its impact essential for sustainable rural development.

Adaptation is frequently used as an analytical concept to analyse the ways in which people cope with and try to reduce the impact of climate change. Scholars agree that the degree to which the system is impacted from climate change depends much on its ability to adapt (Mendelsohn, 2000; Smit *et al.*, 2001; Smith *et al.*, 2000; UNDP, 2008). At the same time the concept is also used in a more practical-oriented way as a possible solution to the negative effects of climate change. “Adaptation can reduce damage significantly” (Burton, 1997). “Unless we adapt to these changes, sickness, famine and forced migration will be the outcomes” (MERCY CORPS, 2007). Olmos (2001) argues similarly that adaptation to climate change is an urgent matter for rural development.

Some authors argue that efficient and effective adaptation to climate change cannot be obtained autonomously (Smit *et al.*, 2001), while others see it more as a possible effect of planned intervention. Despite these differences, the majority of scholars believes that adaptation is a fundamental process for sustainable development (Smit *et al.*, 2001), whether it occurs as unplanned outcome or planned intervention. It logically follows that the improvement of adaptive capacity to cope with climate change - in both natural and social systems – constitutes a major policy concern in countries affected by climate change.

Vietnam is one of the countries that is hit hardest by climate change because of its long coastline and dependency on agricultural-based livelihoods (Asia Development Bank, 2009). In July 2008, the government has launched the “National Target Programe for Coping with Climate Change”. This programme will be working until 2010 to evaluate climate change impact and formulate action plans and policies to cope with climate change. The objective of the programme will be to build sufficient adaptive polices.

In order to formulate sound adaptation policies and programmes to promote sustainable development, it is important to learn and improve the knowledge of the past and present adaptation as well as the process of making adaptation decisions (Adger *et al.*, 2002; Nicholls & Klein, 2000; Smit *et al.*, 2001). Within existing communities, different individuals, households, and groups there exists different abilities to adapt to climate change (Coulthard, 2008). Studying

these differences in adapting capacities can contribute significantly to both the theoretical and the empirical understanding of how policies can facilitate adaptation.

The Tam Giang-Cau Hai lagoon system which belongs to the Thua Thien Hue province is the largest of the South East Asia and provides the livelihood means for more than 300.000 people in the 31 communes located around it (Truong Van Tuyen & Brzeski, 1998). Income generation activities depend mainly on lagoon resources such as fishing, aquaculture and agriculture. Annually, however, the lagoon ecosystems as well as its residents are affected by natural disturbances such as heavy rain, extreme temperatures, floods, storms and surge tides that make the dynamic of this ecosystem unstable. These instabilities in turn contribute to large losses in fish catch; declining aquacultural productivity and loss of assets. Lagoon residents, especially fishers and aquaculturalists, experience the dynamic of climatic change. It is the continuously changing condition in which these people work and the ways in which they try to adapt and reduce its negative effects, which form the context of this research.

According to Ellis (2000), diversifying income generating activities is used as a vehicle for spreading risk. As such it is an important strategy of rural households, who rely significantly on natural resources for sustaining a livelihood, to manage uncertainty and the effects of change. The capacity which people use to make a living for themselves determines how they will act in the face of climate change (Coulthard, 2008). Hence, this research examines adaptation by focusing on income diversification of the two groups - fishers and aquaculturalists.

The hypothesis of this research is that income diversification is an important form of adaptation for fishers and aquaculturalists in the Tam Giang lagoon to climatic and non-climatic stimuli. Certainly, adaptation is a result not only of the impact of climate change but also an effect of non-climate factors such as overpopulation, overexploitation, environmental pollution and weak resource management. An important part of this thesis is evaluating to which extent diversification can be considered as a true adaption process.

The thesis is divided into 10 chapters. Chapter 1 states the research problem and identifies the research objectives as well as research questions. Chapter 2 clarifies key concepts and approaches which are used to investigate and discuss adaptation as income diversification in the Tam Giang lagoon. Chapter 3 describes the methods and tools used to conduct this research. Chapter 4 presents some key characteristics of the study site. Chapter 5, 6, 7, 8 and 9 outlines and discusses the results from the case-study. Finally, the main conclusions are presented in chapter 10.

1.2. Research objectives

The focus of this research is the heterogeneous nature of adaptation to climate change among fishers and aquaculturalists in the Tam Giang lagoon. More specifically it looks at the factors that prevent these groups from adaptation through income diversification. Such a focus is reflected in the following objectives of this study: (1) to identify the important climate events and the changing nature of these events affecting the livelihoods of fishers and aquaculturalists; (2) to scrutinize the impact of these changes on their daily life, especially in regard to income generating activities; (3) to examine the different income strategies as well as adaptive capacity of the two groups - fishers and aquaculturalists - as responses to the changes identified; (4) to understand the factors that promote or prevent fishers and aquaculturalists from adapting to the changes identified.

1.3. Research questions

In order to achieve the research objectives, the following research question will be answered: Can different income strategies of fishers and aquaculturalists in the Tam Giang lagoon be explained as adaptations to climate change? This general research question can be divided into four sub-questions:

1. What are the important climate events that affect to income generation of the fishers and aquaculturalists and how do these events change the climatic conditions in the study site?

2. How do these changing climatic conditions impact daily rural life, in particular the income generating activities of fishers and aquaculturalists?

3. Do the fishers/aquaculturalists diversify their income generating activities to adapt to the changes/impacts? What are their different income strategies? What are other factors that enable or constraint income diversification and create income differences between fishers and aquaculturalists?

4. Does income diversification of the fishers/aquaculturalists qualify as adaptation to climate change?

CHAPTER II: LITERATURE REVIEW

This chapter describes and analyzes the concepts and approaches related to climate change and adaptation. It is divided into three main sections. Section 2.1 discusses about relevant concepts of climate change and how the climate change. Section 2.2 considers the concepts of impact, approaches to assess impacts of climate change and the impacts of climate change on fishery system. Relevant concepts of adaptation, adaptation approaches and adaptation typologies are discussed more comprehensively in section 2.3. The concepts and approaches discussed in this chapter lay a solid foundation to formulate the research indicators; to choose the methods and tools for data collection as well as to discuss the research results.

2.1. Climate and climate change

2.1.1. What is climate change? - Some definitions and indications.

Adaptation can be understood as a reaction to different climatic stimuli which include, global climate change, variability and extreme events (Smit *et al.*, 2001; Smith *et al.*, 2000). The following will briefly clarify these terms.

Weather is the term used to depict atmospheric conditions using air temperature, pressure, humidity, wind speed and precipitation at a particular time and space (USAID, 2007). *"Weather is the hourly or daily state of the atmosphere"* (Fox & Seielstad, 2003, p. 12).

The weather average during a period of time is called climate. According to the Intergovernmental Panel on Climate Change (IPCC, 1997, p. 9), *"climate is usually defined as the "average weather", or more rigorously, as the statistical description of the weather in terms of the mean and variability of relevant quantities over periods of several decades"*. The quantities include primarily temperature, precipitation and wind variables.

"Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extreme, ...) of the climate on all temporal and spatial scales beyond that of individual weather events" (IPCC, 2007, p. 872). According to Francis and Hengeveld (1998), climate variability is a natural characteristic of the climatic system and occurs as a short-term fluctuation.

Climate change is defined as *"any change in climate over time whether due to natural variability or as a result of human activity"* (IPCC, 1995 as quoted in Pielke, 2005, p. 549). *"Climate change refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer"* (Hegerl *et al.*, 2007, p. 667).

According to IPCC reports, climate change can be understood as the long-term change in temperature and precipitation average whether high or low. But climate change not only refers to changing means of variables over a long period of time. According to Karl and Knight (1998 in Smith *et al.*, 2000), the frequency and intensity of extreme climate events such as droughts, floods, storms and hurricanes, are also part of global climatic change. Several scholars argue that the frequency and intensity of extreme weather events is increasing (Harmeling, 2008; IPCC, 2007; McMichael *et al.*, 2004; MERCY CORPS, 2007). Katz and Brown (1992) believe that the changing extreme events probably constitute the greatest impacts, especially in the short term vulnerability of natural and human systems. *"Adaptation needs arise often (but not always) from extreme events rather than average climate conditions"* (Füssel, 2007, p. 267). To examine the impact of climatic changes on the fishers and aquaculturalists in the study site, this research will focus on the changes in occurrences of extreme weather and extreme climate events.

Extremes are defined as infrequent events of a particular weather or climate based on their deviation from a average range of temperature, precipitation and wind (Lynch *et al.*, 2008). According to the IPCC (2007, p. 875), *"an extreme weather event is an event that is rare at a particular place and time of year"*. "*When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event"* (Lynch *et al.*, 2008, p. 4). Extreme weather and climate events both include droughts, floods, tropical cyclones, strong winds, hot days and nights, cold days and nights (IOM, 2008; Lynch *et al.*, 2008). The terms "norm" and "abnormal" or "pattern" and "un-pattern" can represent the differences between them. As stated by USAID (2007): *"Climate is what you expect, weather is what you get"*. For example, if floods always occur in November annually, they are characterized as climate extreme events. But, if they occur suddenly in July, they are characterized as weather extreme events. Therefore, apart from frequency and intensity, the abnormal as well as the accuracy of predictability are important indicators to understand the change of climate condition in the study site.

Climate change is evidenced by both the change of means of variables and of extreme events. To understand how the climate situation in the study site changes through extreme events, it is important to get an overall picture of how the global, Vietnamese and Thua Thien Hue climate is projected to change. These climate change pictures will be considered in the next section.

2.1.2. Climate change situation

2.1.2.1. How is our global climate changing?

The change of the global climate system has been proved scientifically. *"Accumulating evidence suggests that in addition to this natural climate variability, average climatic conditions measured over extended time periods (conventionally 30 years or longer) are also changing, over and above the natural variation observed on decadal or century time-scales"* (McMichael *et al.*, 2004, p. 545).

According to the IPCC (2001), the increase of average surface temperature of the earth was already indicated in 1861. Global warming is an unprecedented phenomenon in the historical development of the earth climate system (IPCC, 2007). The temperature has increased by 0.74^{o}C within 100 years from 1906 to 2005 (IPCC, 2007). On average, the earth surface temperature increased by approximately 0.074^{o}C every decade. However, this average rise differs considerably per time scales and geographical regions. For instance, the average rise in temperature in recent 50 years is twice as much as the average rise of 100 years - 0.13^{o}C/decade (IPCC, 2007). The rise in temperature measured at the North Pole is nearly twice as much compared to the global rise - 1.5^{o}C/100 years (IPCC, 2007).

As temperature increases, glaciers at the North Pole, South Pole and Greenland have started to melt at an increased rate. When the snow and ice cover melts, huge amount of water joins the oceans which lead to an immediate rise in sea-level. The global average sea-level raised on average 1.8 mm per year from 1961 to 2003, and has been increasing in recent years (IPCC, 2007).

With higher temperatures, precipitation changes due to an increase in water evaporation. The global precipitation increased by around 1% in the last few decades (Karl, 1996 as quoted in (Fox & Seielstad, 2003). Again, the speed of this change has been significantly different per geographical region. In tropical areas, the rainfall per decade increased from 0.2 to 0.3% (IPCC, 2007), but in sub-tropical areas rainfall decreased by 0.3% per decade (IPCC, 2007). Furthermore, arid and semi-arid regions have become drier, and regions in mid to high latitudes have become wetter as a result from changes in precipitation patterns (McMichael *et al.*, 2004).

Besides, there are changes in the frequency, intensity and distribution of extreme events. The frequency of heavy precipitation events grew from 2 to 4% over the mid and high latitudes of the

Northern Hemisphere, while the frequency of extreme low temperatures reduced considerably (IPCC, 2007). Notably, the frequency and intensity of storms, flood and drought has risen significantly due to fluctuations in average climatic conditions, such as temperature and precipitation (Easterling *et al.*, 2000; Heltberg *et al.*, 2008; IPCC, 2001; IPCC, 2007; Klein & Tol, 1997; MERCY CORPS, 2007). Over the decade of the 1990s, especially, the frequency as well as intensity of such events increased (Mirza, 2003). For that very reason, according to Schipper (2004) and Oxfam (2007), the risk of disasters has increased. As shown in O'Brien et al (2008, p. 7), *"disaster frequency appears to be increasing, from about 100 events per decade in the 1900-1940, to 650 per decade in the 1960s, to 2000 per decade in the 1980s. By the 1990s this number had reached almost 2800 events per decade"*.

Obviously, the increase of temperature leads to the change in precipitation and climate extreme events. By the year 2100, the average global temperature is predicted to have risen from 1.4 to 5.8^{o}C (IPCC, 2007). The earth will be warmer, the melting rate of snow and ice coverage will be higher and correspondingly the sea-level will rise from 0.09 to 0.88 m. (IPCC, 2007). Accordingly, the frequency and intensity of extreme events, which may not be the same rate as temperature and sea-level, is projected to increase considerably.

The accuracy of the predictions of the IPCC reports and other scientific papers has been debated substantially over the world. Despite that the expected rate of change is uncertain; the changes - such as changes in extremes of temperature and precipitation, decrease of ice and sea level rise - are increasingly proven in important and tangible ways (Karl & Trenberth, 2003).

The global climate is comprised by different climate belts, for example tropic and temperate. Each belt has its own characteristics in terms of variables and extreme events. Therefore, the manifestations of change of different climate belts can be different. Vietnam is a tropical country. The manifestations of climate change in Vietnam are certainly different from the global manifestations. How is Vietnamese climate changing? This question will be answer in the next section.

2.1.2.2. The changing climate of Vietnam

Several studies have been done to estimate how the tropical Vietnamese climate has changed in recent decades. Nguyễn Văn Thắng *et al*. (2008) used data from the past 70 years (1931-2000) to argue that the average temperature increased by 0.7^{o}C, which is not far from the global average. The sea-level has been rising much more compared to global averages: in a period of 50 years it rose from 25 to 30 cm. Furthermore, these authors expect that Vietnam will also experience changes in the precipitation rate which are different for distinct regions. For instance, the precipitation has an increasing trend in Da Nang - the Central Coast, and conversely a decreasing trend in Ha Noi and Ho Chi Minh - the North and South respectively. Furthermore, the authors mentioned that the frequency of storms operating on the East Sea as well as storms landing on the Vietnamese coast decreased during the last four decades from 114 storms in the 1960s to 68 storms in the 1990s. The intensity of these storms has increased and the storm season has been extended.

Moreover, according to Lê Đức Năm and Lê Quang Tuấn (2008) and MARD (2008), extreme low temperature in Vietnam have become more common. According to Watson *et al.* (1998); Nicholls *et al*. (1999) as quoted in (Klein *et al.*, 2000), increased coastal flooding in South and Southeast Asia, Africa, the southern Mediterranean coasts, the Caribbean and most islands in the Indian and Pacific Oceans is expected to increase in intensity. This means that Vietnam will also experience more severe flooding. In the next decades, these several climate extreme events are expected to become more frequent, intensive and abnormal in parallel with an expected temperature increase of 3^{o}C by 2100 (Lê Đức Năm & Lê Quang Tuấn, 2008; MARD, 2008).

Vietnam is such a long country. The considerable disparity in latitude couple with variety in topography creates different climate zones (Nguyễn Ngọc Truyền, 2004). Therefore, the change of climate condition can be varied from place to place compared to the general change of the whole country. This study is conducted in Thua Thien Hue province - the Central Coast of Vietnam. The specific change need to be discussed to understand how the climate in Thua Thien Hue changes, hence. This discussion will be presented in the next section - section 2.1.2.3.

2.1.2.3. Climate changes in the Thua Thien Hue province

Thua Thien Hue is located in the North Central Coast of VietNam and is annually hit by a number of storms and floods. A number of contradicting changes in these extreme events, as well as average climate conditions, have been observed by some scientists and organizations.

Analyzing statistic data from the Thua Thien Hue hydrometeorological station over the stage of 1997 - 2007, Le Van An and Ho Dac Thai Hoang (2007) concluded that there is no significant change in terms of temperature and annual rainfall. Conversely, IMHEN and NCAP (2008) claimed that the annual temperature and rainfall from 1974 to 2004 has increased considerably. The rate is different among geographical regions - higher in the mountain areas and lower in the delta and coastal areas. In case of rainfall, changes are quite different depending on different time scales. The rainfall decreases from June to July and from January to March in the mountain and delta and coastal areas; from August to December the rainfall reaches its highest point in both regions.

In terms of extreme events, the frequency as well as intensity of storms reaching Thua Thien Hue has increased from 1961 to 1990 and decreased from 1991 to 2000 (IMHEN & NCAP, 2008). According to Le Van An and Ho Dac Thai Hoang (2007), however, there was a higher frequency of storms and floods from 1997 to 2007. The results of IMHEN and NCAP seem to concur with national variations.

The climate has changed. The change certainly impacts, whether positive or negative, on the global life of fauna and flora, particularly of the human. In order to overcome the negative impacts and salvage the positive one, the impacts need to be assessed. The impact assessment approach as well as impact of climate change on marine species, fisheries and the coastal residents will be discussed in section 2.2.

2.2. Climate change impacts

2.2.1. Terminology clarification

Impact is defined as *"the striking of one body against another"* or *"the effect of one thing on another"* (http://www.thefreedictionary.com/impact, 03/11/2010). Correspondingly, climate change impacts are defined as *"the effects of climate change on natural and human systems"* (IPCC, 2007, p. 875). According to the Webster Dictionary (http://www.webster-dictionary.net/definition/impact, 03/11/2010), impact is referred to as undesirable.

Climate change impact assessment is defined as *"the practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems"* (IPCC, 2007, p. 875).

There is a given agreement that the climate change impacts are severe. Different systems are affected differently by climate change. How can climate change impact on the fishers and aquaculturalists living around the Tam Giang lagoon be understood? Approaches to climate change impact assessment are discussed in the following section – section 2.2.2.

2.2.2. Assessing impacts of climate change: different approaches

Scholars assess the impact of climate change over time based on climate scenarios. A number of these have focused on changes in mean conditions - temperature and precipitation. Aalst et al.

(2008) contradict this 'top-down' approach with a 'bottom-up' approach. The latter is grounded in the knowledge that changes in the manifestation of extreme climate events are at least as important as the changes in mean climate condition (Adejuwon *et al.*, 2001). Moreover, the approach also pays explicit attention to differing degrees of adaptation of people impacted by climate change. According to Adejuwon *et al* (2001, p. 90), *"*[…] *the consequences can differ for different members of the same community—as when some individuals or groups perceive an opportunity with change, and others experience a loss, thereby changing community dynamics and complicating decisions about how to adapt"*. Hence, an understanding of the processes through which local people try to adapt to climate change, requires an assessment of the manifested occurrence of extreme climate events but importantly also the perceptions of the aquaculturalists and fishers.

Sterr *et al*. (2000) divide the impacts of climate change into three categories: population; marketed goods and services; and non-marketed goods and services. Several authors have problematised the conventional assessments of climate change. The common indicators to measure impact are quantitative and most often monetized. Unfortunately, using monetized indicators will omit the impacts in terms of population as well as non-marketed goods and services. Accordingly, this research aims to apply both monetized and non-monetized indicators to measure the impacts of climate change.

Furthermore, according to Nicholls *et al*. (2007) and Klein (2002), the increasingly human-induced pressures such as overpopulation, poverty, natural resource degradation, environmental pollution aggravate the impacts of climate change. The impacts of climate change in the developing countries are not caused by climatic factors but also non-climatic factors such as socio-economic, culture and others (Bodley, 2001, quoted in (Schipper, 2004). For this reason it is very difficult to assess precisely what the impact is of climate change on rural livelihood security.

To some extent, the impacts of climate change on different sectors - for instance, agriculture, fishery and livestock - as well as systems - for instance, natural and human - are assessed by a number of scientists and organizations. How climate change impacts on marine species, fishery and coastal residents - the focus of this research – will be taken in to account in the following section.

2.2.3. Impacts of climate change on marine species, fishery and coastal residents

Different geographical regions, sectors, systems or individuals are impacted unequally by climate changes. In order to reach the research objectives, however, this section only focuses on the impacts of climate change on marine species, fishery and coastal residents. From the literature review, it seems that it is difficult to designate how climate change impact on marine species, fishery and coastal residents separately, because there exists a strong interrelation between them.

Temperature is the key factor affecting the productivity and distribution of fishery (IPCC, 2007; Pinnegar, 2006). According to IPCC (2007), the warmer atmosphere has changed the ocean circulation in the tropics, which led to a reduction in productivity of both aquaculture and capture fisheries. Temperature differences in the water constitute the habitat boundaries for different species of fish. Fluctuations in temperature, affect the growth rate of fish. Furthermore, the occurrence of El Nino in South and South-East Asia also negatively affects the fertility and growth of fish species. The abundance and distribution of pathogens and Periodical harmful algal blooms (HABs), which harm aquatic organisms as well as human health and pollutes the water, are influenced by climate change (Nicholls *et al.*, 2007).

Table 2.1: Impacts of climate change on marine resources, fishery and coastal resident

Change item	Concrete manifestation	Impacts	References
Temperature	Increase of temperature	- Reduced marine species growth rate - Reduced fish larvae - Enhanced and created serious marine disease - Increased toxic alga - Changed and increasing marine species migration - Created health risk for human	(IPCC, 2007; MARD, 2008)
	Decrease of temperature	- Increased mortality rate of fishes - Menhaden (*Brevoortia tyrannus*) in Atlantic or Mullet (*Mugil spp.*), Tarpon (*Magalops atlanticus*) and others - Changed and increased marine species migration	Burton et al, 1997 and Overstreet, 1974 as quoted in (Roessig *et al.*, 2005)
Precipitation	Increase of rainfall intensity	- Increased mortality rate of fishes and shellfish due to salinity reduction and fluctuation - Inundation	(Lê Đức Năm & Lê Quang Tuấn, 2008)
Sea-level rise	Sea-level rise	- Changed the chemical components over the ocean can affect to the growth and distribution of fish - Salinity intrusion to estuaries leads to heighten the mortality of fresh and brackish marine species - Inundation - Fresh water degradation	(IPCC, 2007; Lê Đức Năm & Lê Quang Tuấn, 2008)
Extreme events	Increasing of extreme low temperature	- Reduced in terms of quantity and type of marine species	(Lê Đức Năm & Lê Quang Tuấn, 2008; Mirza, 2003; Nicholls *et al.*, 2007; Sterr *et al.*, 2000)
	Increasing of flood	- Inundation - Broken infrastructure - Asset loss - Human loss - Human health	
	Increasing of storm	- Broken infrastructure - Asset loss - Human loss	

In the Central Coast of Vietnam, according to MARD (2008), the increase in water temperature causes a number of serious *Vibrio* bacterial and viral diseases for shrimp that lead to yield failure for aquaculturalists. Moreover, a large number of aquaculturalists loose income because of massive die-off of shrimp and fish due to associated water pollution. Moreover, high fish mortality rate or massive fish die-off also occurs when water temperature reduces excessively (Burton et al, 1997 and Overstreet, 1974 as quoted in (Roessig *et al.*, 2005). In addition to productivity reduction, fluctuations in temperature also affect the distributions of marine species. Tuna catch of East Asia and South East Asia contributes to about one-fourth of the world's total (IPCC, 2007) and makes a considerable input in the livelihood of a large number of people. However, this improvement has been set back through the changes in distribution and migration pattern of tuna caused by the rise in temperature of one degree (Lehodey et al., 1997 and ICCAT, 2002 as cited in (Roessig *et al.*, 2005).

The high morality and changed distribution of marine species is also caused by an increase of intensive rainfall and sea-level rise. These changes cause an abnormal fluctuation and alteration of salinity levels that in turn affect to the habitats of marine species (IPCC, 2007; Lê Đức Năm & Lê Quang Tuấn, 2008). Moreover, they also cause inundation and degrade fresh water sources which negatively affects human living conditions (IPCC, 2007; Lê Đức Năm & Lê Quang Tuấn, 2008).

Besides the impacts caused by the change in temperature, precipitation as well as sea-level rise, the impacts cause by the change of extreme events are enormous. Marine resources can be wiped out by an extreme increase of temperature. Lives, assets and infrastructure become lost due to increases in flooding and storm. According to (Sterr *et al.*, 2000), the number of people affected by coastal flooding in 1990 were more than 200 millions. Moreover, this number can increase by three times in 2100 (Sterr *et al.*, 2000). These impacts directly affect rural livelihoods negatively - especially poor rural households. The impact of these climate extreme events depends much on the socio-economic context in which these households find themselves. However, generally the poor are the people who take greatest impacts from these extreme events (Mirza, 2003).

Coastal zones are considered to be productive ecosystems that supply fundamental goods and services for human social and human well-being (Kelly & Adger, 1999). However, this wealth has been impacted negatively by climate change. Consequently, the livelihood of coastal residents depending on coastal resources, has also been negatively impacted. For this reason, impact avoidance or reduction plays a critical role in maintaining and improving livelihood security. Given the agreement that adaptation is one of effective means to avoid or reduce the impacts of climate change. Still, how can adaptation to climate change be understood? In order to answer this question, it is important to understand of adaptation terminologies, typologies and approaches, which will be discussed in the next section, section 2.3.

2.3. Adaptation to climate change

2.3.1. Terminology clarification

"Adapt" refers to a process of adjustment to changing circumstances. According to Winterhalder (1980 quoted in (Smithers & Smit, 1997), the term adaptation sprang from the natural sciences and reflects the genetic changes in organisms induced by a process of natural selection. The concept has been widely applied in social sciences as well, and has especially been used in research on climate change (Smithers & Smit, 1997).

In defining adaptation, two major schools of thought can be distinguished. The first sees adaptation as adjustment to reduce the negative impact of change. For instance, Smit & Wandel (2006, p. 282) argue that *"adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity*". The second school refers to both the negative

impact and opportunities in the term of adaptation. For example, Adger and Vincent (2005, p. 78) claim that *"adaptation as an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impact in order to alleviate adverse impact of change or take advantage of new opportunities"*. According to Adejuwon *et al.* (2001) and USAID (2007), however, climate change produces globally both risks and opportunities. Moreover, according to Mendelsohn (2000), the forms of adaptation to climate change can represent both that of reducing damages and of taking advantage. In case of the Tam Giang lagoon, the changes of the flood regime almost do not bring any advantages or opportunities to the fishers and aquaculturalists. Therefore, the adaptation definition of this study would only mention to the adjustments to the risks of climate change.

In the literature on climate change, adaptation is often used exclusively for successful adjustments to confront climate change. This is misleading since adaptation also involves failure. Adaptation to climate change is a process in which the people historically adapt to climatic stimuli in a dynamic environment (Adger *et al.*, 2003; Füssel, 2007). Failure is an indispensable part of this process. According to Feenstra *et al* (1998), the increase of damage from climate events in many areas proves that adaptation is not always effective, failed adaptations and that maladaptive options occur. Correspondingly, the term "maladaptation" has been used to depict the extent to which adaptation fails (Klein & Maciver, 1999). Maladaptation include avoidant reactions (denial of the threat, wishful thinking, fatalism) and "wrong" adaptations that unintentionally increase the damage done through climate change (Burton, 1996 quoted in (Grothmann & Patt, 2005).

Successful adaptation depends critically on the capacity of human ability or system to adapt to stimuli. In order to depict this capacity, scholars use the term "adaptive capacity". "Adaptive capacity is the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change" (Smit *et al.*, 2001).

In addition to the term "adaptation", "coping" is also used to characterize responses of human in confronting with climate change impacts. For some scholars, the two terms are used as synonym, for instance *"coping is defined as a response to a perceived stressor, ..."* (Heerwagen & Diamond, no date, p. 10.83). Coping behaviors can be divided into three general classes: a) behaviors aimed at changing the situation in some way (environmental coping); b) changes in one's own behavior (behavioral coping); c) attempts to adjust to a situation by managing emotions or thoughts about the situation (emotional/psychological coping) (Heerwagen & Diamond, no date). For others, however, the two terms are quite different. Lazarus (1993, p. 237) argues that *"coping is defined as ongoing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person* […]. [Coping] *is used whether the process is adaptive or non-adaptive, successful or unsuccessful, consolidated or fluid and unstable"*. According to Davies (1996 quoted in (IPCC, 2001), there is a confusion in terms of concept between coping and adaptation. The discussion on adaptation will lose its value if we do not address these confusions - the difference between coping and adaptation (Schipper, 2004). These issues will be discussed in the next section, section 2.3.2 consequently.

Table 2.2: Adaptation definitions

Adaptation definition	References
Adaptation involves change, in response to environmental conditions, which maintains, preserves or enhances viability of the system of interest. p. 139	(Smithers & Smit, 1997)
Adaptation refers to adjustments in individual, group, and institutional behavior in order to reduce society's vulnerabilities to climate, and thus reduce it impacts. p. 159	(Pielke, 1998)
Adaptation refers to adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts. p. 881; p. 225	(Smit *et al.*, 1999; Smit *et al.*, 2001; Smith *et al.*, 2000)
Adaptation in the context of climate change refers to any adjustment that takes place in natural or human systems in response to actual or expected impacts of climate change, aimed at moderating harm or exploiting beneficial opportunities. p. 18	(Klein, 2002)
Adaptation to climate change is the adjustment of a system to moderate the impacts of climate change, to take advantages of new opportunities or to cope with the consequences. p. 192	(Adger, 2003)
The term adaptation is used here to mean adjustments in a system's behaviour and characteristics that enhance its ability to cope with external stresses. p. 8	(Brooks, 2003)
Adaptation is the action of responding to experienced or expected impacts of changing climatic conditions to reduce impacts or to take advantage of new circumstances. Adaptation is not about returning to some prior state, since all social and natural systems evolve, and in some senses co-evolve with each other over time. p. 3	(Tompkins & Adger, 2004)
Adaptation as an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities, p. 78	(Adger & Vincent, 2005)
Adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity, p. 282	(Smit & Wandel, 2006)
Adaptation to climate change is some time understood as a strategy for preventing all adverse impacts of current and future climate change. p. 268-269	(Füssel, 2007)

2.3.2. Coping and adaptation – the same or different?

The differences between coping and adaptation are contested, although there is not literature which explicitly discusses this issue. The difference in temporality and sustainability is the principal distinction between coping and adaptation (IPCC, 2001; Smit & Wandel, 2006; Smithers & Smit, 1997). Coping occurs in the context of immediate dangers and is aimed to overcome acute damage. The purpose of coping actions is thus to survive in an adverse situation. Selling assets or livestock in exchange for food lost from unexpected flood or fleeing to a place with higher altitude are examples of coping strategies in response to events of climate change. Contrary, the purpose of adaptation is to prevent or limit current and future damage of events of climate change. Adjusting seasonal calendars or building a high and permanent house to avoid annual floods are considered to be examples of adaptation to climate change.

It becomes clear that coping and adapting are different ways to respond to risk that cannot be interchanged (IPCC, 2001). There is, however, also a relationship between coping and adaptation. According to Lazarus (1993), the effectiveness of coping can produce an outcome which can be considered as adaptation. Similarly, an outcome considered as maladaptation can origin from ineffective coping strategies which degrade long-term capacity to escape from poverty or cope with future extreme events (Osbahr *et al.*, 2008). In a continuous adaptation process, coping can be understood as the lowest level of adaptation if it shows effectiveness on the long-term. Contrarily, it can cause maladaptation if it impedes the capacity of the people to adapt to the future shock events.

2.3.3. Adaptation typologies

The adaptation strategies undertaken by people differ considerably. These specific adaptation practices rely on a number of factors such as: social and economic endowments, ecological location, social network, institutional relationship, and access to resources (Agrawal, 2008). Each type of adaptation practice has its own characteristics. Nevertheless, there have been many efforts to categorise different adaptation strategies, in particular to be used as knowledge for the development of policy and planning.

Adaptation options are categorized based on various criteria. Firstly, depending on timing, adaptation can be either reactive or anticipatory (proactive) (Füssel, 2007; Klein & Maciver, 1999; Klein *et al.*, 2003; Klein & Tol, 1997; Klein, 2002). Reactive adaptation appears after the occurrence of climate change impacts, while anticipatory adaptation takes place before climate change impacts occur. These distinctions seem to be clearly identifiable conceptually. However, in practice this proves to be quite difficult. In the context of continuous changing system, reaction and anticipation blend together (Fankhauser *et al.*, 1999; Klein & Tol, 1997). For instance, concrete houses built on hills in the coastal area to prevent flood damages can be seen as both reactive and anticipatory action. They are results of reactive action if they are built to prevent only past and current flood regimes. They are results of anticipatory action if they are built in consideration of a warmer future. In reality they are probably built in consideration of past, present and future.

Secondly, adaptation can also be categorized either as *autonomous* or *planned* (Carter *et al.*, 1994; Füssel, 2007). Autonomous adaptation is defined as *"natural or spontaneous adjustments in the face of a changing climate"* (Carter *et al.*, 1994, p. 32) without any policy plan or decision. Conversely, planned adaptation is adjustment which takes place in accordance with the intervention of the government - or any other informed decision-maker. The planned adaptation is made based on perceptions of climate change and the need to act to respond to such changes (Klein & Tol, 1997). This distinction is conceptually clear, but is again ambiguous in practice. For example, the change in crops and management practices of the farmers is seen as

autonomous adaptation from government's perspective while as planned from famers' perspective (Fankhauser *et al.*, 1999). Planned adaptation can be both reactive and anticipatory while autonomous adaptation is exclusively reactive.

Thirdly, depending on the concerned actors, adaptation can be categorized as public and private (Füssel, 2007; Klein, 2003; Klein, 2002; Smit *et al.*, 2001). Private adaptation is undertaken by individual households or commercial firms while public adaptation is undertaken by governments. According to Mendelsohn (2000), private adaptation is performed for the individual's own benefit whilst public adaptation offers benefits for many. However, the distinction between private and public is also problematic. Although adaptation is undertaken by private individuals or firms, it is affected by government policies, in some cases (Smithers & Smit, 1997). According to Klein (2003), autonomous and planned adaptation overlaps with private and public adaptation, respectively. This statement can be proved by the following figure (figure 2.1).

		Anticipatory	**Reactive**
Natural Systems			· Changes in length of growing season · Changes in ecosystem composition · Wetland migration
Human Systems	**Private**	· Purchase of insurance · Construction of house on stilts · Redesign of oil-rig	· Changes in farm practices · Changes in insurance primiums · Purchase of air-conditioning
	Public	· Early-warning systems · New building codes, design standards · Incentives for relocation	· Compensatory payments, stubsidies · Enforcement of building codes · Beach nourishment

Figure 2.1: Matrix showing the five prevalent types of adaptation to climate change, including some examples. Source: Klein (2002)

Fourthly, depending on duration, adaptation can be either tactical or strategic (Smit *et al.*, 1996; Smithers & Smit, 1997). Tactical adaptation is performed in the short-term in reaction to a damaging situation - "*tactical actions comprise the daily or weekly management decisions made in response to an immediate stimulus"* (Smithers & Smit, 1997, p. 141). On the contrary, strategic adaptation is performed on the long-term - *"strategic actions represent more enduring, often anticipatory, actions which are made with a view to the longer term and which alter the nature of the activity in some way"* (Smithers & Smit, 1997, p. 141). For example, the selling of livestock or the use of relief foods in Sudan and Mozambique is ranged as examples of tactical adaptation (Osbahr *et al.*, 2008; Osman-Elasha *et al.*, 2006), while the structural changes in land use or livelihood activities are ranged as the strategic adaptation. This type of distinction seems quite similar to the distinction between the term "coping" and "adaptation", as previously discussed.

Fifthly, according to Carter *et al*. (Carter *et al.*, 1994) adaptations can be distinguished based on the intended or unintended character of their underlying decisions. Intended decisions are taken in considering the damage of climate change. Whilst, unintended decisions follow incidentally but nevertheless reduce the climate change impacts. As with the foregoing distinctions, this differentiation also becomes difficult to operationalise in actual practices.

Adaptation measures are categorized into a number of types. The category is ambiguous and overlapped. It depends much on specific context. In order to understand how adaption measures in the study site are categorized, adaptation approach which is discussed in the next section, section 2.3.4, plays a critical role.

2.3.4. Adaptation approach

Adaptation is widely considered essential in confronting climate change impacts, and receives significant attention of policymakers. Adaptation in practice is a multifaceted phenomenon and differs depending on contextual circumstances which need to be examined in order to contribute to sound policies. According to Smit *et al.* (1999), there are three critical questions which need to be answered to understand adaptation: Adaptation to what? Who or what adapts? And how does adaptation occur? Adaptation to what needs to be answered to identify the stimuli that forces people to adapt. Stimuli in this research, are the changing manifestation of extreme climate events which affect significantly income generation of the local people. Who or what adapts needs to be answered to identify which systems, sectors or individuals have to adapt to the stimuli. Fishers and aquaculturalists are identified in this respect as the adapting actors. How adaptation occurs needs to be answered to identify the forms of adaptation and the process through which they manifest themselves. This question receives less attention of scholars (Kelly & Adger, 1999; Smith *et al.*, 2000), which is why this research tries to compensate for this shortage by looking at the process of how and why the fishers and aquaculturalists diversify their income sources to adapt to climate change.

According to Klein (2002), different levels are involved in adaptation to climate change: the strategic level, the population level and individual level. The strategic level aims at changing the attitude of the populations and individuals with respect to climate change. The population level aims at protecting against or impeding impacts and facilitating adaptation by individuals. The individual level aims at reducing impacts and focuses on behavioral adjustments. But in practice these three level purposes coincide, for example, the population level can also aim at changing individual's awareness. Hence, adaptation at these three levels is interrelated and difficult to separate in reality. According to Coulthard (2008), the understanding of how adaptation is negotiated at the level of individual and household plays a critical role in taking into account how to heighten the existing adaptive capacity. In Vietnam, the household is recognized as an independent economic unit from 1989 (under the "doi moi") (Lê Mạnh Hùng *et al.*, 1998). Therefore, individual household level is the main focus of this research to understand how the adaptation process is taken, nevertheless, in regarding to the strategic and population level.

A household is defined as a unit of people who share the same house and food, and work to contribute food and income to the unit. The common household in the study site includes two generations: parents and their children. Population level refers in this research to the number of households who live within the same administrative borders - a village.

Adaptation to climate change happens in the context of dynamic social, economic, technology, biophysical and political conditions of the system, sector or individual. The decision to adapt is influenced not only by climate stimuli but also non-climatic factors (Agrawal, 2008; Füssel, 2007; Klein, 2003; Klein & Tol, 1997; Smit *et al.*, 2001; Smith *et al.*, 2000; Smithers & Smit, 1997). Therefore, it can be difficult to single out adaptation to climate change from adaptation to other disturbances (Adger *et al.*, 2005). Accordingly, in order to answer the main research question, it is necessary to also investigate the non-climatic factors which affect to decision making of the local people.

Moreover, according to Smit *et al*. (2001) and Kelly and Adger (1999), the context conditions of the system (as mention above) also decides the capacity of this system to adapt - adaptive capacity. *"The capacity to adapt is a critical element of the process of adaptation: it is the vector of resources that represent the asset base from which adaptation actions can be made"* (Adger & Vincent, 2005). Therefore, the discussion of this issue will be presented in the next section.

2.3.5. Adaptive capacity

Adaptive capacity presents the potential, capacity or ability to adapt rather than adaptation practices (Brooks *et al.*, 2005; Dolan & Walker, 2003; Smit *et al.*, 2001). The higher the adaptive capacity is, the more adaptation options are available. According to Adger and Vincent (2005), the adaptive capacity of a system depends on its economic developed level. If the system has a high level of economic development, they will have more resources available to implement adaptation actions. The resources that influence adaptive capacity are portrayed as adaptive capacity determinants. However, adaptive capacity determinants are not always quantified by economic number. According to Yohe and Tol (2002), these determinants also include the technological option availability for adaptation, the resource availability and their distribution, the critical institution structure, the human and social capital stock, access to risk spreading mechanism, the decision-maker ability to manage risks and information. Still, these determinants are different depending on different system or circumstances in terms of type and volume. *"Adaptive capacity is context-specific and varies from country to country, from community to community, among social groups and individuals, and over time"* (Smit & Wandel, 2006, p. 287).

According to Grothmann and Patt (2005), however, adaptive capacity determinants characterized as objective adaptive capacity only partly determine adaptation decisions and actions of the system. Coulthard (2008), from the research in Pulicat lagoon in India, argues that contrary to conceived wisdom poor people,- Dhonirevu fishermen - have a higher capacity to adapt to environmental change compared to the non-poor - Pattinaver fisherman.. According to Adger *et al* (2008), the shortage of knowledge about future climate change impacts, i.e. risk perception, is the main reason causing difference in adaptive capacity. Nevertheless, in the Pulicat case study the non-poor do perceive the risk from the environmental change - as they stated: *"these days we earn one-tenth of what we use to earn from fishing"* (Coulthard, 2008); they just decide to not take adaptation actions.

Why do some people adapt whilst others do not? To explain this question, Grothmann and Patt (2005) use another component of adaptive capacity - perceived adaptive capacity - which comprises three sub-components. Firstly, perceived adaptation efficacy is defined as the extent to which effectiveness of adaptation is believed. Secondly, perceived self-efficacy is defined as the extent to which person's ability to adapt is self-recognized. Thirdly, perceived adaptation costs refer to the amount of costs to spend on adaptive responses. In case of Coulthard (2008), the non-poor do recognize their ability to adapt - *"we can dress well"*, however they *"sit and wait it out"* because even *"the three traditional Padu villages (Pattinaver fisherman location) might be very backward in income but we are still in front in facilities and lifestyle"* (Coulthard, 2008). It seems that adaptation decision and option is not as "effective" as their position and caste - the perceived adaptation efficacy is not believed by the Pattinaver fisherman - the non-poor. High risk perception associated with high perceived adaptive capacity produce adaptation while high risk perception associated with low perceived adaptive capacity produce maladaptation (Grothmann & Patt, 2005).

Besides adaptive capacity determinants, risk perception and perceived adaptive capacity also play an important role in determining adaptive capacity. However, they are still neglected in the climate change adaptation literature (Grothmann & Patt, 2005). Therefore, in order to investigate the adaptive capacity of the fishers and aquaculturalists, this research need to consider both adaptive capacity determinants and risk perception and perceived adaptive capacity.

CHAPTER 3: METHODOLOGY

This chapter describes the methodology used to accomplish the research. It explains what and how the data was collected and analyzed. Qualitative interview is the main method used to answer the research question. Firstly, the description of how the study site was selected is presented in section 3.1. Secondly, the methods of data collection and data analysis are discussed in section 3.2. Finally, some difficulties faced during the fieldwork are indicated in section 3.3.

3.1. The study site selection

The Quang Phuoc commune, in the Quang Dien district of the Thua Thien Hue province was selected for this research. The selection was based on the several criteria. Firstly, Quang Phuoc is stretching along the Tam Giang lagoon and is a low, sunken commune which means that it contains many of the main characteristics of coastal areas, and for this reason frequently hit by storms, tide surges and floods. Secondly, the livelihood of the people in Quang Phuoc commune still relies much on the natural resources of the lagoon. Thirdly, Quang Phuoc commune close to the district centre - Sia town and the province centre - Hue city where the people can acquire income from non-farm activities.

The field work was conducted in the two villages of Quang Phuoc commune - Phuoc Lap and Mai Duong. The former mainly consists of rural livelihoods for which fishing is the main income resource, while the latter mainly consists of livelihoods which rely on aquaculture for their main income. Secondary data was collected at the commune level. The social-economic context of the Quang Phuoc commune in general, as well as for the two villages in specific, will be discussed in the chapter 4.

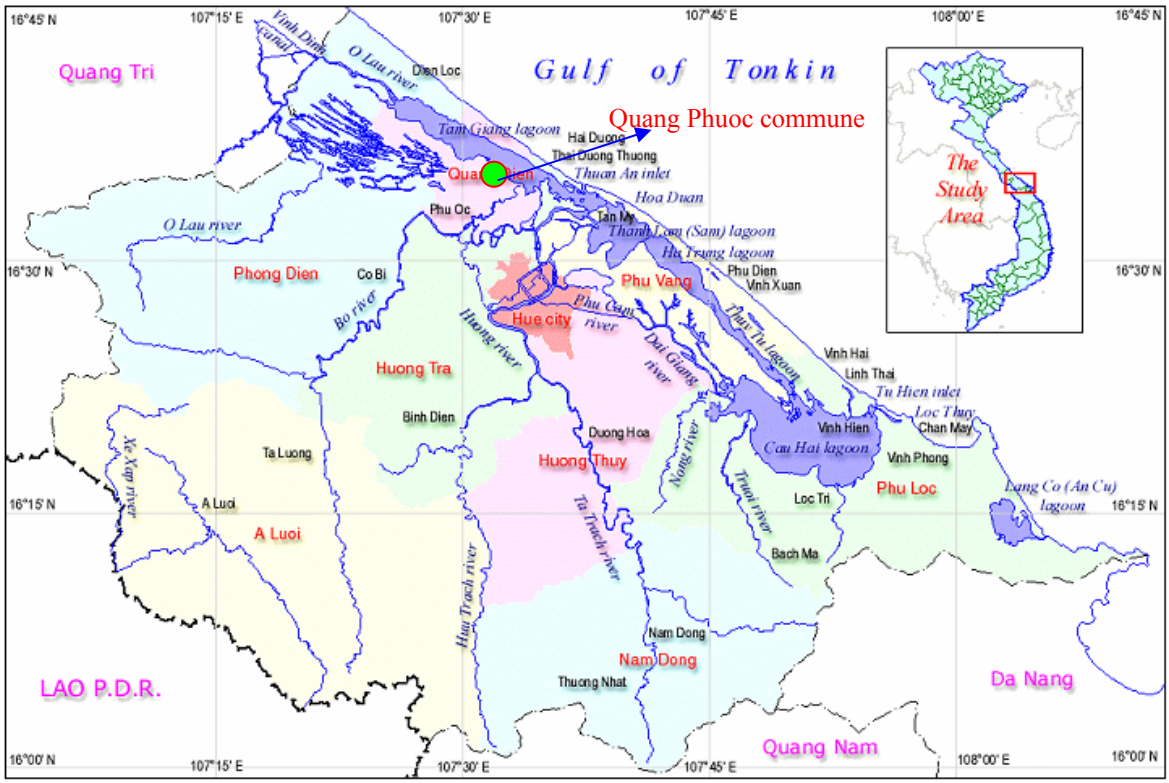


Figure 3.1: Location of the study site (Source: www.imolahue.org)

3.2. Research methods

3.2.1. Introduction

The general objective of this research is to investigate the heterogeneous ways in which fishers and aquaculturalists adapt to climate change and to identify factors affecting these patterns of adaptation. This general objective is comprised of four specific objectives (as mentioned in section 1.2 of chapter 1). Different evidence and methods were used to obtain these four specific research objectives.

The first objective is to identify the important climate extreme events affecting the livelihood of fishers and aquaculturalists. It is also to investigate the change of these extreme events by using some identified indicators such as frequency, intensity, duration, abnormal, degree of predictability and trend. Methods used for this data collection are: in-depth interviews with village elders; focus group discussions with village elders; mapping; social memory mapping; and semi-structure questionnaires.

The second objective is to assess the losses that people face as a result of climate change. These losses can be direct such as losses of: money, yields (fish and shrimps), lives and food. Losses may also indirectly cause a decline in income opportunities and declining resource abundance. Secondary data (The commune annual reports) and primary data (focus group discussions using timelines and semi-structure questionnaires and in-depth interview with aquaculturalists and fishers) was collected to estimate these losses.

For the third objective - to examine the different income strategies as well as adaptive capacity of the two groups - fishers and aquaculturalists - to confront with the changes identified - in-depth interviews and focus group discussions with the fishers and aquaculturalists was used as the main method. These methods needed to bring out existing coping options to reduce immediate negative impacts; adaptation options to overcome continuous impacts; the number of income sources as well as their efficiency and sustainability.

Finally, to work towards the fourth objective - to understand the factors that promote or prevent and create the differences between the fishers and aquaculturalists from adapting to the changes - indicators related to social, environmental, economic and human factors were analysed. Social factors include: poverty, social position, access to resources, services and networks. Economic factors include: climatic sensitive livelihoods, financial situations, access to credit and assets. Human factors include: education levels, health situations, risk perception and perceived adaptive capacity. Beside secondary data collection, primary data was collected through: in-depth interviews with commune officers, fishers and aquaculturalists and focus group discussions.

3.2.2. Data collection method

*** Secondary data collection**

Secondary data was analysed by using the commune annual reports and flood damage annual reports from the past five years and previous climate-related researches. This data provides the basic overview of the changing climate conditions, social-economic conditions as well as experiences how these changes influence the daily life of the local people, i.e. the fishers and aquaculturalists in the study site. The research also includes data on property right regimes, lagoon resource situation, aquacultural development, and livelihood activities in the Tam Giang lagoon. Moreover, government policies and programmes launched to mitigate the negative effects of climate change were gathered to examine how these enable or constrain local adaptive capacity.

*** Qualitative interviews**

Qualitative interviews are the key method to answer the research question - Can different income strategies of fishers and aquaculturalists in the Tam Giang lagoon be explained as adaptations to climate change? The reasons for choosing this method are the following: (1) it is a useful method to describe a social or political process - explain how and why things change rather than numbers; (2) it can help the researcher delve out the research topics by following on the given answers (Rubin J. H & Rubin S. I, 2005). The method included focus group discussion and in-depth interviews.

- Focus group discussions

The focus groups include 5 - 7 key informants to get *"in-depth information about how people think about an issue - their reasoning about why thing are as they are, why they hold the views they do"* (Laws *et al.*, 2003, p. 299). The research conducted 4 focus group discussions with various key informants and used tools to organise the discussions.

Two focus group discussions with village elders who retired from fishing and aquaculture were organized to obtain an overview of the general climatic conditions, the important extreme weather events, and how these have changed over the past 30 years in the study site. Mapping, social memory mapping and semi-structured interviews were used during this discussion. Mapping was used to examine the distribution of natural resources, residents, infrastructure and vulnerable locations in respect to climate change. Social memory mapping was used to understand the long-term dynamic of climate change and the behavior of the local people after these changes. *"Social memory is pertinent to the study of environmental change and the subsequent reactions of societies over time"* (Coulthard, 2008, p. 2). Semi-structured interviews were used to investigate the loss and damage caused by these changes and its impact on local life. It helped to obtain an overall picture of how local people cope with these changes.

Two other focus group discussions were organized with fishers and aquaculturalists who have lived in the study sites and fished and/or developed aquaculture for at least 15 years. We applied the same tools so that we could see the differences between the two focus groups in their perception of climate change; losses; and in adaptive changes.

Timelines with critical determined points related to the most important extreme event were used to understand how people cope with and adapt to changes. These tools were used to focus more on income diversified strategies of households. Livelihood analysis was used to understand the circumstances of the people in facing climate change as well as helping to identify which factors influenced their adaptive capacity. Semi-structured interviews were used during the discussions to comprehend the damages and losses due to the changes; adaptation of the people and others.

- In-depth interview

In-depth interviews were conducted with different key informants to explore different topics related to the research questions and objectives (as mentioned in chapter 1). An in-depth interview can be used to obtain detailed information about a person's thoughts and behavior as well as investigate deeply the new issues (Boyce & Neale, 2006; Guion, 2006). The respondents were selected purposefully through a discussion with the two village authorities. Besides, the number of respondents were decided upon based on the rule that the adequate sample size will be reached if the interviewees tell the same stories, issues and topics (Boyce & Neale, 2006). The following will briefly describe the respondents interviewed.

Three village elders who retired from fishing/aquaculture were interviewed to acquire their perspective on the changed climate conditions, especially the changed occurrence of extreme weather events, such as floods. The interviews were also used to reconstruct their life stories related to the changes in the climate.

Nine fishers and eight aquaculturalists who have practiced fishing and aquaculture in the study site at least 15 years were interviewed. The interview started with some discussions about the changing flood regime which was collected from the elder focus group discussion to triangulate information. Then, it focused more to examine how these changes impact fishers' and aquaculturalists' daily life, especially their income generation. It also tried to find out how they diversify their income in order to compensate for losses, and which factors promote or constraint them from diversifying. The interviews also dealt with their life histories to understand what they experienced in facing changing climate in general and changed flood regime specifically.

Two commune officers, including the commune leader and a fisheries official were interviewed to obtain their perception on climatic changes, its impacts and the support of the commune for local people to cope and adapt with these changes.

Before conducting the focus group discussions and in-depth interviews, the researcher also has informal interviews with the commune vice-chairman, two former village leaders, two village leaders, four hamlet leaders, one fisher as well as one aquaculturalist to get some initial information and build a relationship. The two types of qualitative interview - in-depth interview and focus group discussion were not conducted in order. They were used to complement each other.

In addition, participant observation was also used to understand more the situation of culture, habit, custom, and behavior in the community as well as individual households that are affected in their adaptive capacity in the study site. Participant observation is useful to differentiate between what people do and what they say they do (Laws *et al.*, 2003).

3.2.3. Data analysis

The process of transferring raw interviews into evidence-based interpretation is defined as data analysis (Rubin J. H & Rubin S. I, 2005). Building an analysis, however, is not straightforward work because the qualitative data is large and detailed and comes from different sources. The first step of the data analysis process is the transcription of raw data from interviews. This work was done not only after but also during the fieldwork time to supplement deficient data. After having the completed transcriptions steps were taken to classify, compare, measure and combine data in order to come to an evidence-based interpretation. Each transcription was classified to identify the answers for each research questions. Next, each specific answer was compared across interviewees to find patterns of similarity and difference. An understanding of these patterns could be used to answer the research questions as well as support the arguments. Based on this analysis some specific answers could be omitted if they were proved as invalid and wrong answers. Finally, the overall pictures, or stories, of respondents were constructed through combining specific answers as well as events. The quotes presented in chapter 5, 6, 7 and 8 are not the transcriptions from the interviews, but they try to capture as much as possible in the respondent's own words what has been said.

3.3. Difficulty in collecting data and doing fieldwork

Firstly, it is difficult to collect the commune annual report as well as flood damage annual reports for a long time (more than 5 years) in Quang Phuoc commune. There is no electronic system to manage and store these reports. The commune officers only store the reports which were made from 2005 on paper. Therefore, I could not collect the data, especially on flood frequency as well as flood damages for a long time (the expectation was that I could take these data from the past at least 10 years).

Secondly, there were difficulties in arranging interview and group discussion with the people in Phuoc Lap and Mai Duong village. The time for doing fieldwork coincides with the time of rain and flood. The road to the two villages was often flooded therefore I could not reach them to do the arranged discussions. Sometimes, the focus group discussion could be conducted after being

arranged three times. Under the nice weather, moreover, it was also difficult to meet the fishers for in-depth interview. The fishers usually go fishing from 4 p.m and come back to their home 6 a.m of the day after. After coming back, they sleep until 12 a.m. Therefore, I often had to wait until they got up to interview. It was take much time.

CHAPTER 4: BACKGROUND OF THE STUDY SITE

This chapter discusses some background information of the study site. The discussed information is essential to understand the context in which fishers and aquaculturalists diversify their income to adapt to the change. It is divided into three sections. The first gives the general picture of the Tam Giang - Cau Hai lagoon - section 4.1. The second describes some basic information of the study site in general - Quang Phuoc commune as well as in specific - Phuoc Lap and Mai Duong village - section 4.2. Then, the indicators for selecting the research sample are presented in section 4.3.

4.1. The Tam Giang lagoon

The Tam Giang - Cau Hai Lagoon system is the biggest lagoon of South East Asia and is located along the North Central Coast of Vietnam. It spans over a wide area in the Thua Thien Hue province with around 70 km in length and 20,000 ha in area. The lagoon is considered as one of the areas hit hardest by floods and storms in terms of both frequency and intensity - . The Cau Hai Lagoon system comprises 6 lagoons which include (from North to South): Tam Giang, Sam Chuon, An Truyen, Ha Trung, Thuy Tu and Cau Hai respectively. The lagoon receives freshwater from numerous inland rivers such as O Lau, Bo, Huong and Truoi and connects with the Eastern sea through the Thuan An and Tu Hien estuaries (see figure 3.1, chapter 3). The exchange between freshwater and saltwater creates geographical and seasonal salinity fluctuations (Tôn Thất Pháp *et al.*, 2002) and consequently a typical biodiversity (Trương Văn Tuyển, 2010b) in the lagoon system.

From an ecological perspective, the Tam Giang - Cau Hai lagoon system regulates the climate, controls floods and dissolves waste matter, and reproduces marine species. Moreover, the lagoon plays the critical role in the social-economic development of Thua Thien Hue. Around 30% of the total population of Thua Thien Hue - 300,000 inhabitants - live in the 31 communes around the lagoon. One third of the inhabitants depend on lagoon resources for their livelihood through fishing and aquaculture. However, the lagoon's productivity is declining due to pressures from agricultural development, overexploitation, deforestation of mangrove forest and overpopulation (Lê Thị Nam Thuận, 2010; Trương Văn Tuyển, 2010b).

Fishing is the traditional livelihood activity of the inhabitants living around the Tam Giang lagoon. The people practicing fishing are categorized into two groups, depending on their access to lagoon resources. These groups are called "Đại nghệ" ("large business") and "Tiểu nghệ" ("small business") or fixed fishers[1] and mobile fishers[2] respectively. Fixed fishers are thus considered rich when compared to the mobile fishers (Tôn Thất Pháp *et al.*, 2002). Fishing is practiced in an open access regime in the Tam Giang lagoon (Trương Văn Tuyển, 2002). Since access is free, the size of these two groups has increased significantly, mainly as a result of population growth. This extensive growth leads to an intensive growth and a 'race for fish'(Butcher, 2004), which in turn further marginalizes the rural livelihoods in the lagoon. According to the statistics of the Thua Thien Hue Fishery Department, the total fish catch from the Tam Giang lagoon has reduced with 50% within three decades – from 4,500 tons in 1980 to 2,500 tons in 2007. *"It is a tough situation now. The fish catch is about two-tenth of what we used to catch. In the past we earned millions and hundreds VND, but presently we earn only*

[1] Those who have right to fishing grounds on which they set fixed fishing gear such as fish corral and bottom net are categorized as fixed fishers.
[2] Those who do not have right to fixed gear fishing grounds are categorized as mobile fishers.

around fifty thousand VND per day" (Phan Kien - a fisher in the Dien Hai commune, Phong Dien district as quoted in (Hoàng Văn Minh, 2009)).

In the late 1980s, the Vietnamese government launched a policy to develop aquacultural enterprises with the purpose is to improve fishers' income and to reduce the exploitation pressure on the lagoon (Tôn Thất Pháp *et al.*, 2002). The area in the lagoon used for aquaculture increased swiftly, from 1,800 ha in 1999 to 3,200 ha in 2001 (Thua Thien Hue statistics, 2007). The development of aquaculture brought many positive changes to the lagoon livelihoods in terms of income and living standard. Based on criteria of the Ministry of Labour, Invalids and Social Affairs (MOLISA), the aquaculturalists living around Tam Giang lagoon were categorized as better-off households (Nguyễn Thị Thanh, 2002). The rise in income also resulted in improvements in health care and education (Tôn Thất Pháp *et al.*, 2002). However, the expansion of aquaculture enterprises occurred unplanned and led to environmental pollution and numerous diseases affecting the species bred in these enterprises. Together these problems have destructed aquacultural enterprises and led to an impoverishment of the livelihoods of aquaculturalists (Nguyễn Ngọc Phước & Trương Văn Tuyển, 2010). Moreover, the unplanned and unregulated development also caused the impoverishment of mobile fishers by spatially reducing their fishing ground (Trương Văn Tuyển, 2002).

The negative effects of this development are gradually explicated through the critical efforts of the scholars, authorities as well as the local residents. These findings slowly become incorporated in the livelihood strategies, state policies and community based management governance. Moreover, apart from the development pressures, the lagoon ecosystem as well as the livelihood dependent on the lagoon resources have suffered from the impacts of global climate change (Lê Thị Nam Thuận, 2010; Trịnh Việt An, 2000). The challenges of global climate change coupled with the ecological pressures stemming from development processes (e.g. aquaculture) accelerated the impacts - lagoon productivity degradation - that press the inhabitants, authorities as well as scholars to overcome and adapt to survive and develop.

So far, the adaptation strategies as income diversification of the people in the Tam Giang Lagoon have not been studied substantially. The majority of studies conducted in the Tam Giang lagoon focus on income diversifications in respect to the property right regime (Dương Viết Tình & Tôn Thất Chất, 2002; Nguyen Thi Tuyet Suong, 2006; Nguyễn Thị Thanh Hương & Phạm Thị Nhung, 2010; Trương Văn Tuyển, 2010a). They only discussed on the current situation of income diversification such as estimated the number of income sources, income portfolio and described income activities. The others focus on adaptation with respect to climate change (Phạm Thị Diệu My & Bùi Vĩnh Long, 2009; Tran Xuan Binh *et al.*, 2006). However, they only mentioned the adaptation in terms of infrastructure, preparation before floods or storms come and overlooked income diversification. How and why the people change the adaptive strategies as income diversification in time to cope with the change (development pressures or climate change or both of them), the constraining factors to diversification and the analysis of adaptation or maladaptation are omitted. This is unfortunate, since such knowledge is essential to be able to facilitate these strategies in state policy and planning. This thesis is an effort to overcome this hiatus with a study of the ways in which residents in the Tam Giang Lagoon change their livelihood strategies in reaction to the change.

4.2. Social and economic contexts of the study site

4.2.1. Social and economic contexts of Quang Phuoc commune

Quang Phuoc is home to 1835 households equivalent to 8071 heads which are divided into 8 villages, of which 5 villages are categorized as coastal villages because of their proximity to the lagoon. There are 364 poor households[3] (19.84%) that mainly occupy the lagoon coastal

[3] Households have an average income of less than 200.000 VND per head per month (the criteria of MOLISA).

villages. The livelihood of Quang Phuoc's residents depends significantly on agriculture and fishery which both are practiced by more than 80% of the total population. Hence, the income from these sectors occupies a large proportion in the total income on household level - more than 70%. The average income per capita is 8.9 million VND per year which is low compared to the provincial and national averages.

The location in the low section of Bo River is characteristic for the Quang Phuoc commune. The low and sunken area is annually struck by floods and storms, which impact on diverse aspects of the Quang Phuoc livelihoods. Quang Phuoc is one of the communes that are hit hardest by floods, concerning intensity and duration. Moreover, the impacts seem every year to become more severe due to the lack of investments in infrastructure – e.g. dams, irrigation,

Climate factors play a critical role in the development of the natural resource-based economy of the Quang Phuoc commune. Climate impacts are always mentioned in the annual social-economic reports of the Commune as main causes for loss and failure of production in especially aquaculture and fishing. These losses reached a peak during the years 2002-2009 (Cao Thị Hồng Nhung, 2008).

4.2.2. Social-economic context of Phuoc Lap village

Phuoc Lap is a traditional fishing village which was established in 1985 in relation to the settlement of the sampan dwellers. The current population of Phuoc Lap is 790, which is equivalent to 150 households. The livelihood of these inhabitants depends significantly on the lagoon resources - fishing and aquaculture. Fishing is practiced by the majority of households - 110 households including 18 fixed fishing households and 92 mobile fishing households. The number of households which practice aquaculture (shrimp cultivation) has increased significantly, from 10 in 1999 to 45 in 2001. From 2002, the cultivation of shrimps failed due to shrimp diseases and "tieu man" flood. Since aquaculture requires relatively large investments, it meant that a large proportion of these households went bankrupt. They fell in deep debt to the bank and were not able to start new aquaculture enterprises. At present there are about 30 households breeding shrimp and fish in ponds.

There are 25 poor households and 15 semi-poor households[4] occupying 16.7% and 10% of the total population respectively. Observing these numbers, outsiders might think that Phuoc Lap residents enjoy a relatively good life because the number of poor households is lower than the commune average - 19.84%. However, according to Phuoc Lap village leader, these numbers are only a paper reality. In actual practice, the number of poor households in this village can amount to more than 50% of the total population. The considerable different between the numbers on paper and reality can be explain as "poor management". The number of households categorized as poor depends on the allotment of the commune government to the village. They only assign households with old, lonely and disabled people and with many children (more than 7) as 'poor'. Consequently, it is only these households in Phuoc Lap who get a certificate stating that they are poor. It is estimated that the better-off[5] only contain 5 households, which operate small businesses with rice and daily commodities for their income. The rest - 105 households - are categorized as middle household[6].

A considerable part of the population of Phuoc Lap village is formed from the former sampan dwellers who settled there after 1985. The education level of this group is considerably low. About thirty percent of this group is illiterate, and the rest has not completed primary school. According to Phuoc Lap authorities, only the young generation who were born after the

[4] Households have an average income of from 201.000 to 205.000 VND per head per month.
[5] Households have an average income of more than 250.000 VND per head per month.
[6] Households have an average income from 206.000 to 250.000 VND per head per month.

settlement time has the possibility to go to school. However, the majority of them can get only the secondary school level, due to poverty, i.e. the inability to pay education fees. The weakness in education is a constraint which limits the betterment of their livelihood. Phuoc Lap is also the village which has the highest birth rate of the commune. The percentage of women who have more than two children take up 60% of the total women of the village.

4.2.3. Social - economic context of Mai Duong village

Mai Duong is a farming village which has a long-standing history. It is home to 276 households, equivalent to 1173 heads. Mai Duong residents make a living mainly through rice and aquacultural cultivation. Different from the residents of Phuoc Lap, all the residents of Mai Duong have property rights of agricultural land, on average 500 m^2 per head. It means that everyone cultivates rice for their cash income and in-kind. In addition, more than 70% of the population practices aquaculture - 138 households.

Breeding fish and shrimps in ponds started in 1995 by 3 households. The huge profits of shrimp cultivation attracted an increasingly large number of households and bank investments. Just before 1999, the number of households practicing aquaculture reaches a peak - 132 households. Thanks to aquaculture many concrete and beautiful houses were built; expensive furniture could be brought; households became "millionaires" which changed positively the living standard of Mai Duong residents (for the stage 1997 - 2001). Under the current situation of Tam Giang lagoon, however, these households were impoverished by aquacultural failure (this will be explained deeply in chapter 5). Presently, all of the aquacultural households have a debt of at least 50 million VND which originated from 2002 - 2004 to the banks and others.

The households who fall in deep debt (more than 100 million VND) also get the "priority" to be categorized as poor. As a result, the percentage of poor households in this village is higher than the commune average - 20.2% equivalent to 56 poor households and 8.3% equivalent to 23 semi-poor households. Conversely, the better-off are only 3 households (1.08%) who get overseas remittances. Similar to the situation of Phuoc Lap, these numbers are only a paper reality. *"Actually, there are more than 100 poor households in my village. However, we have to conform to the guideline of the commune"* - Mai Duong village leader's statement. This situation is explained by both Phuoc Lap and Mai Duong village leader that *"We take part in an emulation of poverty reduction. The poverty rate of neighbor communes, especially of the Sia town, considerably reduces. Hence, our poverty rate has to be controlled to reduce."* Since, this is a sensitive issue; it is difficult to get precise explanation at the commune level.

In terms of education level, it is obvious that the people in Mai Duong have a higher education level compared to people in Phuoc Lap. The lowest education level in this village is the secondary school level. Secondary school, college as well as university are attended by a large number of Mai Duong residents.

In short, despite the common features in the Quang Phuoc commune, both Phuoc Lap and Mai Duong have their own specific characteristics which are summarized below (table 4.1):

Table 4.1: Basis characteristics of Phuoc Lap and Mai Duong village

Characteristics	Phuoc Lap	Mai Duong
Established year	1985	Long-standing history
Number of households	150	276
Number of poor households	25	56
Number of semi-poor households	15	23
Livelihood activity	Fishing, aquaculture	Agriculture, aquaculture
Average agricultural land/households	0	2000 m^2
Average education level	Illiterate or primary school	Secondary school

4.3. The sample selection indicators

The background information lays a basic foundation for the research to identify the indicators to select the sample for the focus group discussion as well as in-depth interview. Different informants were selected based on different indicators, as summarized in table 3.2. Especially, in case of the fishers, mobile fishers are the targets of this research. Since, firstly they are seen as disadvantaged group among fisher groups (fixed fishers and mobile fishers) locating around the Tam Giang lagoon. Secondly, they occupy a large proportion in Phuoc Lap village - 92/102 fishers - in specific and the Tam Giang lagoon in general.

Table 4.2: The sample size and sample selection indicators for focus group discussion and in-depth interview

Qualitative interview	Phuoc Lap		Mai Duong	
	Sample size	Sample indicators	Sample size	Sample indicators
Focus group discussion with elders	5	- The former mobile fishers - Retired from fishing	6	- The former aquaculturalists - Retired from aquaculture
Focus group discussion with fishers/aquaculturalists	7	- Mobile fishers - Fished at least 15 years	7	- Aquaculturalists - Developed aquaculture at least 15 years
In-depth interview with village elders	2	- Mobile fishers - Over 60 years old	1	- Aquaculturalists - Over 60 years old
In-depth interview with fishers/aquaculturalists				
- The poor	3	- Mobile fishers - Have many children - Fished at least 15 years	3	- Aquaculturalists - Developed aquaculture at least 15 years - Felt in deep debt
- The middle	6	- Mobile fishers - Fished at least 15 years	5	- Aquaculturalists - Developed aquaculture at least 15 years - Felt in deep debt

CHAPTER 5: CLIMATE CHANGE IN THE TAM GIANG LAGOON

As discussed in chapter 2, this research examines the climate change in the Tam Giang lagoon through climate extreme events. In order to answer the first sub-research question - What are the important climate events that affect to income generation of the fishers and aquaculturalists and how do these events change the climatic conditions in the study site?, this chapter is divided into two sections. Section 5.1 takes into account the relation between fisheries and climate conditions, and then indicates the important climate events - floods - that hit hardest to income generation of both the fishers and aquaculturalists. Section 5.2 is reserved to consider the change of these events.

5.1. The relation between fisheries and climatic conditions

The local climate is divided into two main seasons - the dry season which starts from early February until early August, and the wet season which starts from the middle of August and ends late January. The dry season is characterized by high temperatures and low precipitation. From late May to early August, the temperature reaches a peak between 25 - 38^{oC} (Nguyễn Ngọc Truyền, 2004) which causes high precipitation and drought. Conversely low temperatures, 10 - 20^{oC} especially from early December to late January (Nguyễn Ngọc Truyền, 2004), and high precipitation are the main features during the wet season.

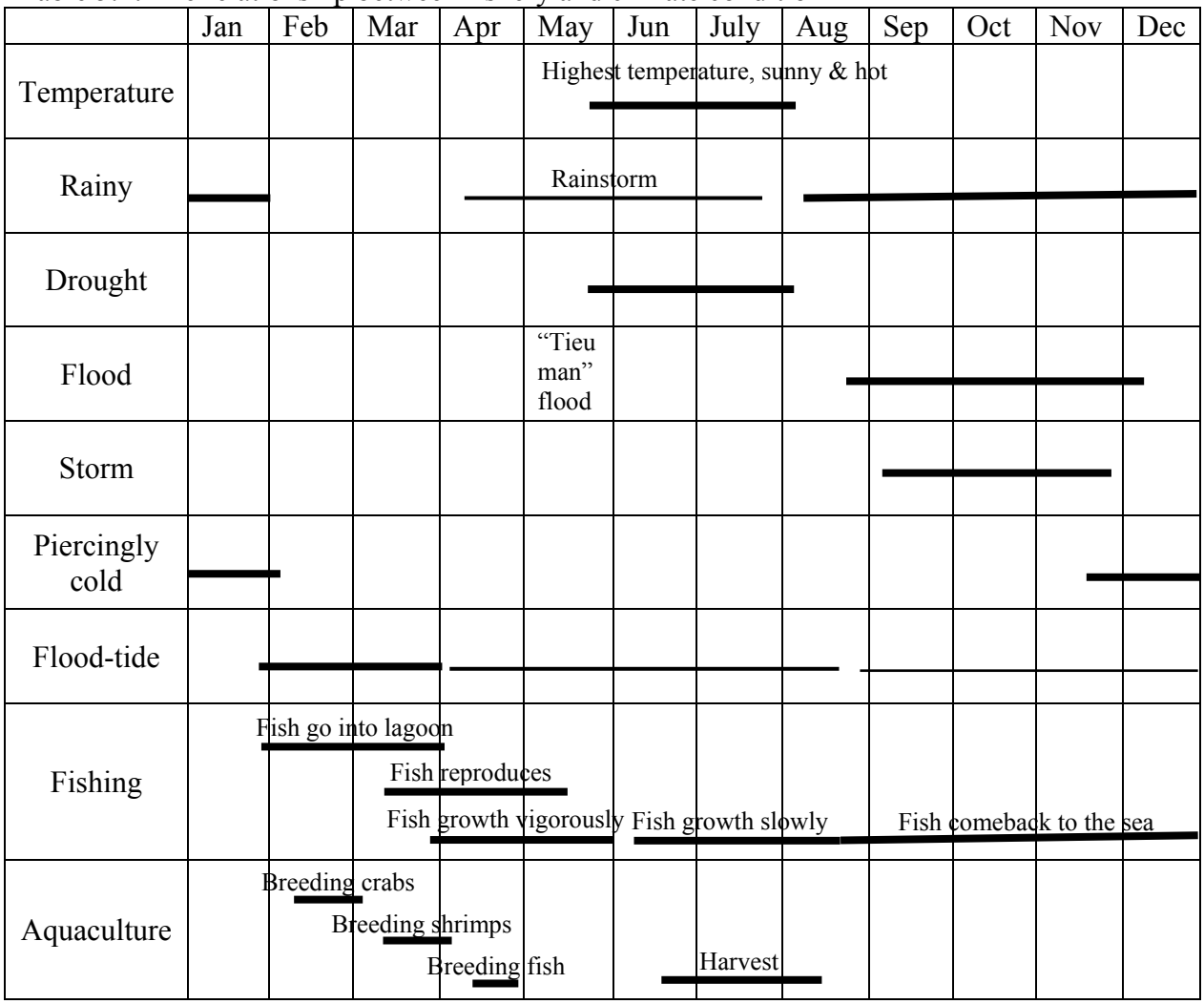
Located in the centre of Vietnam, the Thua Thien Hue province in general and Quang Phuoc in specific are affected by both the North-East monsoon (a cold wind) and the South-West monsoon (a hot wind). The convergence of cold air from the North and dry and wet air from the South causes heavy rains, rainstorms and tornadoes in the rain season. As a result, Thua Thien Hue is named as the "rain centre" since it has the highest average precipitation of Vietnam (3000 mm/year) (Nguyễn Ngọc Truyền, 2004; UBND Thừa Thiên Huế, 2008). This high precipitation, however, is distributed highly unequal through the year: 65 - 70% during late August into late of December and 30 - 35% during the remaining months. The concentration of precipitation during August-December causes frequent flooding in particular the low and sunken areas around Tam Giang lagoon.

As discussed in chapter 4, the population dynamic of marine species in Tam Giang lagoon is decided significantly by the salinity level in the lagoon. The salinity of Tam Giang - Cau Hai lagoon system fluctuates from 0 to around 33 ‰ depending on a number of factors such as seasonality, precipitation, river flows and the flood-tide regime (Nguyễn Văn Hợp *et al.*, 2005). The salinity rises increasingly during the dry season and reaches a peak in June and July. Flood-tides bring salt water from the sea to the lagoon in the end of January. Following the current of flood-tides, marine species from the sea enter the lagoon for reproduction. The increase of salinity attracts more and more marine species which have a high economic value (Trịnh Việt An, 2005). In addition, the weather in the period from March to May is lightly sunny and cool and creates a favorable niche - in terms of salinity as well as temperature - for the marine species to reproduce and grow. Consequently, these salinity fluctuations are responsible for of the populations of marine species in terms of quantity and quality. These species are important for fishers because they are species which are high in demand. The fishers who participated in the focus group discussion highlighted the importance of the dry season:

"Annually, the period from February to May is seen as the "peak time" for fishing. Fishing in this time can provide enough money for our family to live one year. The money we get from one day fishing is significant and exceeds our daily expenses. This means that we can save money which is used to pay for the education of our children, furniture, and reserve some food for the flood time".

The breeding of fish also depends critically on the level of salinity. Aquaculturalists cultivate crab (*Scylla serrata*), tiger shrimp (*Penaeus monodon*) and Kinh fish (*Cyprinus centralus*) in the same pond - namely mixed model cultivation. The crab and tiger shrimp are bought from breeding farms in Da Nang - far from Quang Phuoc about 130 km in the South. The salinity level ranging from 10 to 30 ‰ is appropriate for the growth of tiger shrimp. Therefore, the suitable time for breeding tiger shrimp fluctuates from the middle of March to early April – when the salinity level is high. Crab can accept a lower salinity environment - about 5 ‰. Hence, it is bred before tiger shrimp around one month. On the contrary, Kinh fingerlings are obtained from the lagoon. Kinh fish parents originate from the sea and come to the lagoon for reproduction. Aquaculturalists buy small Kinh fish - the size as big as a thumb – from fishers. Therefore, the time for breeding Kinh fish is rather late in the season - from middle to the end of April.

Table 5.1: The relationship between fishery and climate condition



Source: Focus group discussion with fishers and aquaculturalists

In June the growth of marine species reduces gradually due to the bad weather - sunny and hot - as well as due to the high salinity. The fish catch reduces to 50 - 60 % of the catch during "peak time". This is also the time for aquaculturalists to harvest. Shrimp is usually collected only once per crop because it reacts negatively to the high salinity level - higher than 25 ‰. The tight time for harvesting shrimp often reduces benefit for aquaculturalists because the abundance of supply allows the middlemen to keep the price low. Crab and fish are harvested depending on market prices and size. This means that they can be harvested and sold during a longer time interval, but nevertheless before the floodings.

The yields acquired from fishing and aquaculture from June to the early August can be diminished substantially by the *"tieu man"* flood, which occurs at end of May. This flood is caused by a muster of heavy rainstorms. The term *"tieu man"* means small. The more intensive this flood, the lower the fish catch and aquacultural yield are. The *"Tieu man"* flood can cause environmental shocks for marine species in both the lagoon and shrimp ponds in terms of fluctuations in temperature as well as salinity level. The level of the shock correlates positively to the intensity of the *"Tieu man"* flood. Besides, if the *"Tieu man"* flood is big, flood water comes close to or over the pond bank, then it forces fish, shrimp and crap in the pond to go outside; and it prevents marine species from the sea entering the lagoon. It means that aquaculturalists sometimes can harvest nothing from their aquacultural cultivation. The fishers have to wait at least one month for the inflow of salt water brought by the flood-tide to be able to catch fish again.

Different from the flood-tide, the floods bring freshwater from the rivers to the lagoon in the middle of August. As a result of this the salinity level is reduced to zero. The deluge of freshwater during rainy season flips the Tam Giang from a saline lagoon to an almost freshwater lake. The sudden reduction of salinity can be considered a shock for the majority of marine species which love salinity. Also, the strong power of water currents coming from the high slope rivers drives the majority of marine species to the sea. Fish catch reduces critically due to massive dying of fishes and migration to the sea.

"Immediately after the floods, especially the big one, we come back to our homes with empty boat - no fish and shrimp" - stated by Mrs Son - a 48 years old woman in Phuoc Lap village.

However, some marine species can withstand the low salinity and survive and grow in the lagoon, for instance goby (e.g. *Oxyurichthys papuensis, Awaous ocellaris, Arcygobius baliurus, Glossogobius giuris)*, mullet (*Liza melinoptera, Moolgarda pedaxaki*) and Chi shrimp (*Metapanaeus ensis and Metapanaeus affinis*). The fish catch reduces to 30 - 35 % of the catch during "peak time". According to Trịnh Việt An (2005), fresh water compels the lagoon to become a poor biological zone with species low in economic value. It means that captured fish is sold against a low price. In addition, the number of fishing days also declines. Floods are usually accompanied with strong winds and waves. Since the fishing activity in Tam Giang lagoon is artisanal, the fishers cannot go to fish in such circumstances. During the floods, the maximum number of days that fishers can go to fishing is only 10 - 15 days per month.

Apart from floods, some marine species can also be killed by the low extreme temperature in December to January. The fish catch continues to decrease to only 10 - 20 % of the catch during "peak time". Still, this reduction is not such a drawback to fishers, as compared to the effects of the floods. According to the elders, cold temperature is usually not coupled with floods. If there is a flood, the temperature will not drop much and vice versa.

"The reduction of fish catch in the cold time can be compensated by an increase of fishing days - 20 - 25 days per month. There are no floods in such months - December to January" - said by Mr. Cuong - a 54 years old fisher.

The floods, flood-tides, precipitation as well as temperature, whether high or low, affect negatively the yield of both fishing and aquaculture. However, the floods obviously have the largest effect on the fish catch and aquacultural productivity. The fishers cannot get any fish during the floods, while aquaculturalists can lose their complete harvest. They both agree that floods are the climate events which impact the most on their livelihood. The people always refer the term "flood" as the principle actor that causes loss in fish catch as well as aquacultural yield in all focus group discussions as well as in-depth interviews.

In sum, the productivity of Tam Giang lagoon depends significantly on climate conditions. The propitious climate creates the highest yield for fishers and aquaculturalists. The more favorable

climate - particularly less floods in both intensity and frequency, the higher fish catch as well as aquacultural benefit. These climatic fluctuations have always impacted on livelihoods. However, recently it seems as if these fluctuations have changed.

"The climate changes a lot compared to the time when we were young. It becomes worse and worse, more and more floods occur that reduces the number of fishing days as well as fish catch" claimed by Mr Ngo - a 63 year old man in Phuoc Lap village.

Does the flood regime really change and how does it change? The answer of these two questions will be discussed in the next section.

5.2. How is the flood regime changing?

Every year, there are several floods affecting the Quang Phuoc commune. However, only a small percentage of these floods turn into disasters which cause an acute loss of property and lives. The floods which change into disasters are locally named as "big floods" or "century floods", floods of normal proportions are called "floods" and "tieu man" floods. The participants in the focus group discussions and interviewees agreed that the flood regime in the Tam Giang Lagoon has changed. Accessing the social memory of the Tam Giang fishers as well as aquaculturalists reveals a useful comprehension of changes during the last 30 years. The occurrence of big floods or century floods are strongly memorized by the local people, since these floods have had a huge impact on their livelihoods. Both the elders in Phuoc Lap and Mai Duong village almost all have the same remembrance of disasters. With the regular floods and "tieu man" floods it is, however, quite different. The elder fishers mainly remember the change in regular floodings, while contrarily "tieu man" floods are the main concern of aquaculturalists.

There is a strong consensus between fishers and aquaculturalists that the floods have a reduced tendency in terms of intensity but an increased one in terms of frequency after the century flood in 1999. The number of big floods reduced significantly (figure 5.1). Conversely, the number of regular floods grew increasingly. Rain season floods occur normally 3 or 4 times per year at the most. But recently, the local people sometimes can get more than 4 floods per year. The number of floods per year of the period 2005-2009[7] enumerated by the elder fishers - 5 to 7 floods - coincides closely with what is estimated by the commune officers in their annual reports. Moreover, the elder fishers illustrated the abnormal frequency of floods with an old folk song which describes the main characteristics of the climate for each month.

".... In July, the water will jump on the ground (tháng bảy nước nhảy lên bờ), ... In October, teals hover completely full over the field (tháng mười le le bay đầy đồng".

It means that the flood season usually starts in July and end at October of lunar year equivalent to August and November of the solar year. The fishers commented:

"After the century flood in 1999, the flood season stopped following the song that our ancestors created".

It comes later and ends later than in the song described. The first flood has now a tendency to appear in September and the final one can occur in December, or even in January or February (for example the last floods in 2006, 2008 and 2009 appeared at 17th of Feb, 28th of Dec and 12th

[7] The interval 2005-2009 can only be triangulated because commune annual reports of previous years are not available any longer. The conclusion about the change in frequency as well as intensity of floods is similar to other studies conducted around the Tam Giang lagoon (Le Van An and Ho Dac Thai Hoang Le Van An & Ho Dac Thai Hoang (2007). Climate change effects in Tam Giang and Cau Hai lagoon region. *IMOLA PROJECT (Integrated management of lagoon activities)*.; Phạm Thị Diệu My and Bùi Vĩnh Long Phạm Thị Diệu My & Bùi Vĩnh Long (2009). Báo cáo kết quả nghiên cứu thực địa tại xã Quảng An, huyện Quảng Điền, tỉnh Thừa Thiên Huế (The report on field research findings in Quang An commune, Quang Dien district, Thua Thien Hue province). *Hue Centre for Social Sciences and Humanities*..

of Jan respectively) of the next year in terms of solar year. In addition, the duration of floods lasts longer than usual (as shown in table 5.2).

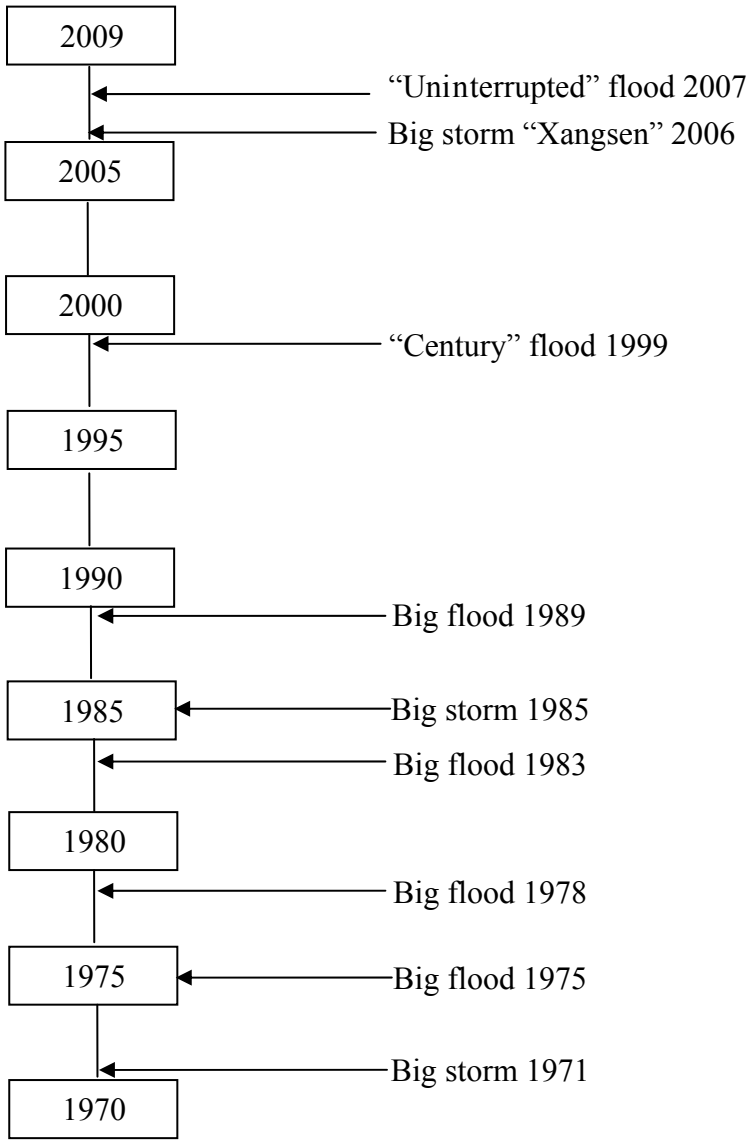


Figure 5.1: Historical analysis of disasters (Source: Focus group discussion with elder fishers and aquaculturalists)

Obviously, floods have changed in terms of frequency, intensity, duration as well as degree of predictability. These changes, in some manner, have been proven by some studies conducted around Tam Giang lagoon. However, the changed regime of another type of flood - the "tieu man" flood - is rarely investigated by scholars who want to understand the changed climate regime. It seems that the meaning of the term *"tieu man"* - small - conceals its dangers and makes why people tend to ignore it. This is a serious shortcoming because the *"tieu man"* flood causes critical losses for the local people (as primarily discussed in section 5.1 and will be discussed in detail in chapter 6) even if it is not as big as the regular floods. Moreover, the regime of the *"tieu man"* flood has change negatively.

The *"Tieu man"* flood neither changes into disaster nor remains as small as its inherent name, but rather has changed in terms of intensity. As Mr Tinh - a 62 years old aquaculturalist puts it:

"Tieu man" flood was often under the pond bank around 30 to 40 cm. In recent years - maybe from 2002, however, it comes over the dam about at least 5 cm and overflow into our shrimp ponds. Though, it is still smaller than the floods occurring in the rain season".

Besides, the time *"tieu man"* is occurring as well as its duration has become difficult to predict by the inhabitants of the lagoon. It normally transpired around the twentieth of April every lunar year and continues one or two days. Nevertheless, at the present, the local people cannot know when it comes and how long it stays. From 2002, the *"tieu man"* flood occurs often earlier or later than the twentieth of April - and stays for more than 3 days. The higher intensity and longer duration of *"tieu man"* flood can be illustrated with a common expression of the aquaculturalists:

"The rain is heavier and lasts longer than normal"

Table 5.2: The change of "tieu man" flood and floods

Flood item / Indicators	"Tieu man" flood		Floods	
	Before	Recent years	Before	Recent years
Frequency (number of flood per year)	1	1	3 - 4	more than 4
Intensity	Small	Rather big	Big	Small
Duration (day)	1 - 2	3 - 7	3 - 5	7 - 15
Abnormal	Around 20 of April	Earlier or later	Start from August to November	Start from September to December, even February
Degree of predictability	Can predict	Cannot predict	Can predict exactly depending on the folk-song and ancestor experience	Cannot predict
Trend		Bigger and bigger		Higher frequency, less intensity

Source: Focus group discussion and in-depth interview with village elders

In conclusion, the regime of both the floods and *"tieu man"* flood in Quang Phuoc commune has changed (as summarized in table 5.2). The changes certainly increase the loss in fisheries and aquaculture caused by the floods. How does this changing flood regime impact on fishers as well as aquaculturalists? The answer will be discussed in the next chapter - chapter 6.

CHAPTER 6: THE IMPACTS OF FLOODING AND THE CHANGING FLOOD REGIME

Impact is considered as a factor that pushes people to adapt. Which types of adapting options that the people take depend much on the types and level of impact. The impacts of floods are different at different time scales, and can be analysed in terms of impact items and impact level. They are changing in accordance with the changing of the flood regime as well as the adaptation of the people. In order to answer the second sub-research question: How do these changing climatic conditions impact on daily rural life, in particular the income generating activities of fishers and aquaculturalists?, the inherent impacts as well as changing impacts of floods need to be concerned. The aim of this chapter is to discuss how and why the impacts of floods on the livelihoods of fishers (section 6.1) and aquaculturalists (section 6.2) change and to also explain why these groups are affected differently.

6.1. The impacts of flooding and the changing flood regime on fishers

The story of Mrs. Le's family - a middle-income household in Phuoc Lap village - helps to substantiate the impact that floods and changing flood regimes can have on rural livelihoods.

"I am 54 years old. All my life, I lost property, and my house even twice, due to the big floods in 1989 and 1999. My family resettled on land in 1986. With the little money we owned, we built a cottage house. However, the cottage house and everything that belonged to it was swept away to the sea by big flood in 1989. We became penniless and homeless. In order to have an accommodation, we had to borrow small sums of money from local lenders against a high interest rate to build the cottage house again. While the loan was not repaid to the lenders, unluckily, our house coupled with some small assets was swept away to the sea by the century flood in 1999. We became penniless and homeless again. Fortunately, we were funded by CRS (Catholic Relief Service) organization to build a house. However, the fund was not enough for us to make a concrete house. The big losses in such a short time made me and my husband to feel anxious for our future. We wondered if we would have to suffer losses again due to the big floods or storms, and how we could maintain our household. After that, we decided to take a loan from bank as well as local lenders to add to the fund to build a desired house. Since we depended on the inundation level of the flood in 1999 to build, our house foundation is very high as well as solid. From 1999 until now, the flood water has never come to our house because certainly we have high and concrete house, and the floods are no longer as big as they were. After having a concrete house, we had to curb our expenses and work hard to pay back our debt. However, the fact does not match our expectation. More and more floods - though not big - occur. The higher frequency of the floods results in a remarkable decrease of fish catch and increase in number of days that we cannot fish. Correspondingly, our income has reduced significantly. So far we have not been able to pay back the debt. On average, we get around 400 thousand VND per month from fishing in the flood season. This money is not enough for our expenditure (for 7 heads) even we try on our best to save."

The story of Mrs. Le's family illustrates some common hardship felt by the households in the Tam Giang Lagoon. Conventionally, loss of housing and property are ranked as the greatest losses that fishers suffer from floods. Before the century flood in 1999, all the fishers in Phuoc Lap lived in cottage houses which were low and ill constructed. All floods, whether small or big, caused harm to their houses and property. The small flood would inflict damage while the big cleared away houses and property. Hence, the fishers usually had to repair or rebuild their house after floods. The loss, poverty and importantly beliefs in the divine that *"disasters caused by the*

God and we could not confront him" all prevented the fishers from having concrete houses. However, the huge loss of houses and assets due to the century flood in 1999 changed this attitude and people wanted to have solid accommodations. The CRS and NAV (Nordic Assistance to Vietnam) organization as well as the State started a campaign and subsidy programme to get people to rebuild with concrete houses. According to the Phuoc Lap village leader, one household could obtain on average 10 million VND. The funds were not enough to build a concrete house. However, the experience of the century flood made that local people tried hard to obtain more money - borrowing from bank, relationships and local lenders – in order to have a "safe" house for the future. Therefore, the majority of the people in Phuoc Lap[8] (144 households)) currently have a high and concrete house although this village is considered as the poorest. Besides, the local authorities always campaign to get people to consolidate their house before the floods arrive. It seems as if fishers forget the losses that floods can cause on their house and property. The fishers do not account much for the danger of floods to their houses and assets due to three reasons. Firstly, the fishers almost all have high and solid houses. Secondly, the intensity of floods has reduced after 1999. Thirdly, they have a good preparation to confront with floods such as consolidate houses and put assets in high place.

Loss of lives is considered by the fishers as the second largest impact of floods on their livelihoods. Lives have been lost in big floods, especially when people try to stay in their houses to protect their property and assets. They think that nothing can harm them because they are good swimmers, and they also stay because they believe that it is not in their power to influence their destiny.

"We thought that our lives were given by the God, we could not do anything to save our lives if he wants to take them" - Mr. Lo - a 65 year old fisher.

The century flood in 1999 changed people's perspectives. When the water of the flood came to their houses, people had little chance to move because the water rose very fast and it was nighttime. Consequently, a number of fishers as well as their children died (around 10 deaths). In addition to the low awareness of the risks involved, the shortage of alarm information also played an important role. After the century flood the alarm information system has been improved considerable. The commune nowadays provides information related to when the floods come and how big they are. This information is communicated to the fishers through loudspeakers placed in the village. The commune authority also has a team to campaign and support the local people to move to higher places when flooding occurs. Moreover, the own awareness of fishers of the risks involved has also changed. These changes have resulted in a much better preparation and has reduced the deaths caused by floods gradually to zero.

"The terror caused by the deaths caused by the 1999 flood always reminds us to do something to prevent this from happening again. Nowadays, when the flood season comes, we usually keep a close watch on the news on television or listen to the information from the loudspeaker in order to be prepared to move." - claimed by the elder fishers.

Besides, the loss of fishing gears and boats, and the shortage of food are also ranked as second largest impact of flooding. These losses are also often caused from a low awareness of the risks involved in not moving during floods, and a shortage of information. Recently, the information on flood prediction has improved through the local authorities. Fishers are now aware that they need to anchor their boats in a safe place and save food for their family in expectation of the coming floods. The middle-income households can save food by themselves while the poor have to borrow money from local lenders to buy food or buy food on credit or get support from the

[8] The rests are elderly and disable households (about 06 households). These households can not able to take loan for building concrete houses.

commune. Currently it seems that the people have enough food during inundation time. As the vice chairman of Quang Phuoc commune stated:

"When we receive the predictions related to floods or storms from the district and province or television news, we inform immediately all of our inhabitants to prepare food, fresh water and firewood which are enough for at least 10 days. In the early rain season the commune has to store food - normally around 2 tons of rice and 500 packages of noodles - which are delivered to the poor. We inform particularly fishers to stop fishing and bring boats and fishing gears to a safe place".

Still, these precautions do not always work out as planned, as fishers explained during a focus group discussion:

"Sometime we forget to tie our boats to the reliable stake" or *"we cannot collect in time our fishing gears put already in the lagoon"*

However, nowadays these losses are negligible. The fishers who forget to tie their boats are only a few. In addition, because the floods are not big enough to sweep away fishing gears, after the flood time the fishers can regain their gears. Obviously, the impacts caused by conventional floods on the fishers are reduced progressively. The improvement of fishers' risk perception, improved construction of houses, saving food before floods and boat anchorage all play a critical role in reducing flood impacts. The fishers have changed their behavior in anticipation of future floodings. This changed behavior can be considered as manifestations of adaptation. The fishers adapted not only by themselves but were also influenced through the support of the local authority as well as some non-government organisations (NGOs). The reduction also makes that the fishers expect a better and more wealthy life. However, Mrs Le's story is a reminder of the emergence of "new" impacts - the reduction in fish catch and the increase in days of non-fishing .

As discussed in section 5.1 (chapter 5), fish catch reduction and an increase in days of non-fishing are also caused by the floods. However, the fishers' perception of the impacts of these processes differs between the two stages - before and after the century flood of 1999. Before this flood, the reduction in fish catch and fishing days are ranked by the fishers themselves as relatively unimportant impacts of flooding. The fishers accepted the reduction as natural process (as discussed in section 5.1) because the money from fishing in the flood season was enough to cover fisher's basic needs.

"At that time, in the flood season, we only stopped fishing in the inundation times which lasted for maximum of 15 days. For the remaining time, one day of fishing could provide us 10 kg rice which is enough for our family to survive day after day" - stated by the fishers in focus group discussion (Phuoc Lap village, 12/12/2009).

After 2001, however, the reduction becomes crucial and starts to impact on livelihood sustainability negatively. The fish catch reduction and increase in non-fishing days is becoming a larger problem due to changes in the frequency of the *"tieu man"* flood and the overall flood regime in the Tam Giang Lagoon.

The change of *"tieu man"* flood regime mainly increases the speed of fish catch reduction. The intensification of the *"Tieu man"* flood reduced the abundance of the economic important marine species in the lagoon. Besides, this intensification is coupled with a longer duration of the flood and as such delays the increase of salinity level. Consequently, the salinity fluctuation keeps the marine species from migrating back into the lagoon from the sea. The lagoon nowadays is a fresh water pond, which is poor in terms of biodiversity as well as economic value, for a longer period of the year. The fishers have to wait at least one month for salt levels to rise again and for the marine fish to come back. In that one month, the fishers said that:

"Normally we can get around 3 kg fish and sometimes 0.5 - 1 kg crab per day on average. But now the fish catch is reduced by more than a half - around 1.5 kg fish. This fish catch can only be exchanged for about 5 kg rice. On average, one household in this village has 6 members. How can we manage with such little rice?"

After one month, despite the rise in salinity level, the fish catch is still not high. The marine species entering the lagoon at this time are usually small. They need time - about one month - to grow. However, their growth ability is relatively constrained by the higher temperatures as well as higher salinity level in July. Thus, the duration of the lucrative catch of marine species is shortened by the change of *"tieu man"* flood regime which now has become more intensive and longer.

"When the big "tieu man" flood comes, we say goodbye to our hope on high fish catches" - claimed by the fishers in the focus group discussion (Phuoc Lap village, 12/12/2009).

Accordingly, the fishers' income is diminished substantially. The fishers only earn half of what they used to earn. Still, the fish catch reduction has not even reached its bottom level; it continues to decline when the flood season comes.

The change of the flood regime primarily accelerates the reduction in fishing days. The inundation days which stop fishers from fishing are multiplied by the higher frequency coupled with longer duration of the floods. As a result, the fishing days per month during the flood season decrease by almost half to 10 - 12 days. Besides, the higher frequency of flooding also increases the speed of fish catch reduction. Consequently, the income per month reduces substantially. The flood season now is characterized as the season of starvation by the fishers interviewed.

Table 6.1: Impacts of flood and changing flood regime on fishers

Order	Impacts of flood regime (before 1999)		Impacts of changing flood regime (after 1999)	
	Impact items	Impact level	Impact items	Impact level
01	Loss of property	+++		
02	Loss of houses	+++		
03	Loss of lives	++		
04	Loss of fishing gears and boats	++	Loss of fishing gears and boats	+
05	Lack of food during inundation time	++		
06	Difficulty in transportation	+	Difficulty in transportation	+
07	Reduced fish catch	+	Reduced fish catch	+++
08	Increased fishing days off	+	Increased fishing days off	+++

Source: Focus group discussion and in-depth interview with fishers
(Note: +++: Strong impact; ++: medium impact; +: low impact)

In sum, the events which impact fishers as well as their level have changed. There are two main reasons for the changes: firstly, the local people had successful adaptation solutions to reduce the great impacts of floods; secondly, the flood regime has changed. The most severe impacts due to flooding do not include loss of house and property any longer. Currently, these are the reduction in fish catch and increase in non-fishing days. In order to survive and develop, the fishers have to response - to find new solutions - to reduce these impacts for both the present and future. The question how they respond will be answered in chapter 8.

6.2. The impacts of flooding and the changing flood regime on aquaculturalists

Similar to the fishers, loss of property and loss of houses were also the most severe impacts caused by the floods for the aquaculturalists. After the century flood in 1999, they also rebuild their houses to reduce future impact. Besides, these houses can protect unhusked rice from losses. However, the aquaculturalists did not receive funding from the NGOs nor the State. Instead they built their houses using their own money. The chairman of Quang Phuoc commune explained why aquaculturalists did not receive any subsidy:

"After the century floods, the aquaculturalists got a lot of money thank to successful aquacultural cultivation - 100 million per household on average. The profit from aquacultural yields in 2000 or 2001 can be used by the aquaculturalists to build concrete houses. In general aquaculturalists are considered as a rich group, while the fishers are ranked as the poor, and they had to confront with many difficulties to recover."

Apart from demolishing houses and property, the big floods also brought opportunities to the aquaculturalists. The big floods could provide a clean environment which is highly favorable for the development of e.g. shrimps. The strong flow of flood water also clears away waste and germs from the shrimp ponds. After every big flood, especially the flood in 1999, aquacultural productivity rose spectacularly. Consequently, the flooding gives aquaculturalists a huge profit, which is the reason why the aquaculturalists were able to build the high and concrete houses by themselves. However, the change of the flood regime marginalised this opportunity and has increased the water pollution. The water flows from the less intensive floods are not strong enough to wash waste and germs from the shrimp ponds into the sea. Next to that these floods also bring more waste from residential and industrial areas located in the mountainous or higher places. A great deal of waste remains in the lagoon. The pollution of the lagoon water slows down the growth ability of the species in the ponds and causes a number of dangerous diseases. The water pollution also inhibits the growth ability of marine species in the lagoon and reduces overall lagoon productivity. However, the fishers do not seem to realize this impact.

Table 6.2: Impacts of flood and changing flood regime on aquaculturalists

Order	Impacts of flood regime		Impacts of changing flood regime	
	Impact items	Impact level	Impact items	Impact level
01	Loss of property	+++		
02	Loss of houses	+++		
03	Loss of lives	++		
04	Lack of food during inundation time	++		
05	Loss of stored food (unhusked rice)	++		
06	Difficulty in transportation	++	Difficulty in transportation	++
07	Shrimp pond edge eroded and broken	++	Shrimp pond edge eroded and broken	++
08	Massive death of shrimp and fish due to environmental shock	++	Massive death of shrimp and fish due to environmental shock	+++
09	All shrimp, fish and crab go outside the ponds	+	All shrimp, fish and crab go outside the ponds	+++
10			Water pollution	++
11	Loss of crop	+	Loss of crop	++

Source: Focus group discussion and in-depth interview with aquaculturalists

(Note: +++: Strong impact; ++: medium impact; +: low impact)

Different from the fishers, the aquaculturalists have to deal with difficulties related to impaired transportation during the floods.

"When floods come, our village becomes an "island". The road is inundated - 0.5 m during the floods and over 1 m during the big floods. The majority of us have no boats. If we want to go out, we have to pay some money for the ferry. However, this is not so convenient. Sometimes we can not find the ferry. Therefore, it is difficult for us to move around" - Aquaculturalists in the focus group discussion (Mai Duong village, 12/24/2009).

The difficulty in transportation is one of constraints that prevent the aquaculturalists from finding secondary jobs in the rain season (after they finish aquacultural and agricultural crops) in the district or city centre (this will be discussed in chapter 8).

Besides, floods also cause damages for aquacultural production. Different types of flood bring different impacts. Floods cause damages on the aquacultural infrastructure while *"tieu man"* flood cause damages on aquacultural productivity. The change of flood regime aggravates the intensity of flood impact on aquacultural activity.

Annually, aquaculturalists' shrimp ponds located around the lagoon shoreline are always eroded and ruined by the floods. Since the shrimp ponds are completely made from stone and soil, they are easy destroyed by strong waves and flows. Consequently, aquaculturalists have to repair their ponds if they want to start a new breeding cycle. As stated by the aquaculturalists:

"We have to spend at least 5 million VND every year to repair our shrimp ponds. This is a large sum of money for us, especially in a situation when harvests have failed."

The cost of repairing reduces the aquaculturalists' profit. Recently these costs have increased due to the increase of costs for building material and labor. Shrimp pond erosion and destruction is ranked as a medium-level impact (table 6.2). Although the floods are not as big as they were, their impact level on the shrimp ponds is not reduced. Still, the aquaculturalists cannot do anything to reduce this impact.

"Building a dam is the unique solution to reduce shrimp pond erosion and destruction. This work cost a lot of money – it can be several billions VND. How can we build it by ourselves?" - Aquaculturalists in the focus group discussion (Mai Duong village, 12/24/2009).

The aquaculturalists request and also expect support from the commune authority. However, as the vice chair man of Quang Phuoc commune stated:

"We know what the benefits for aquacultural activities are when building a dam. But the commune budget is very limited, it is not enough for building a dam. What we can do for our people is to find funding from other sources. We called for investment to the district and some NGOs 3 years ago. However, we have not heard from them since."

The time the *"tieu man"* flood occurs coincides with the time aquaculturalists cultivate their crop. The *"tieu man"* flood causes considerable damage for the aquacultural production. The fresh water from the heavy rain reduces the salinity level to zero. As mentioned before, aquacultural species, especially shrimp and fish, only exist and grow under appropriate salinity level. The sudden change in the water quality of the shrimp pond water leads to an environmental shock for the aquacultural species. As a result, shrimp and fish die in enormous amounts - aquaculturalists call it "massive death". Moreover, shrimp, crab and fish can also crawl over the pond bank to the lagoon if the water level rises close to or over the bank. This leads also to a loss for aquaculturalists. The massive death and losses depends much on the intensity of the *"tieu man"* flood and its duration. The higher these are, the greater are the deaths and losses that aquaculturalists suffer. This statement can be illustrated with the story of Mr. Pham - the pioneer of aquacultural production in Mai Duong village.

"I am 54 years old. I cultivate aquaculture from 1994. I have experienced all the rises and falls of aquaculture. The climate conditions, especially "tieu man" flood, play an important role in determining the success or failure in aquacultural productivity. I suffered a big loss due to "tieu man" flood in 2002. The crop in that year brought nothing to my family. The flood water came over my pond bank and spread net and consequently forced all of shrimp and crab in the pond to the lagoon and sea. I could not respond in time because I thought that "tieu man" flood water could never reach my pond. However, I was wrong. The flood water was higher than its normal level many times and rose very fast. It flooded my pond over 0.5 m. In 1998, I also suffered this loss but it was not worth considering. Due to heavy rain in that time the water in shrimp pond rose close to the bank, a small number of shrimp and crab climbed outside. Since, "tieu man" was small and lasted only 1 or 2 days, I bailed water out the pond by water pump. The migration of shrimp and crab to the lagoon was prevented. That crop provided my family a profit of 30 million VND. After that, before "tieu man" flood come, I spread net around the pond bank to prevent aquacultural species migrate outside. This net is high 0.5 m. The loss was completely overcome prior to 2001. Moreover, the "tieu man" flood water causes shock for shrimp. Since the "tieu man" flood was small and just lasted one or two days, and shrimp can withstand shock for a short while. Only small shrimps sometimes cannot withstand the change in salinity. When the "tieu man" flood leaves, I scatter powdered lime immediately to rescue the majority of shrimp from death. I learned this technique from some training courses provided by the provincial fishery department. It can be said that the "Tieu man" flood has changed since 2002. This kind of flood becomes bigger and lasts longer compared to earlier times. All of my treatments become less effective. Only a high dam can reduce these damages. However, it has not been built yet. Consequently, the aquacultural profit reduces significantly. The more intensity and longer duration of the "tieu man" flood can cost me losses of 10 to 20 million VND per crop."

Moreover, the intensification of the "tieu man" flood brings more waste from residential areas and industrial clusters to the lagoon and into the ponds. Waste pollutes pond water and causes a number of dangerous diseases for shrimp. The growth ability of aquacultural species is constrained and a number of them are killed. As a result, the productivity is reduced. Besides, the aquaculturalists have to spend money to buy chemical medicine to treat the diseases.

In sum, similar to the situation for the fishers, the impacts of flooding on houses, property and lives of aquaculturalists are more and more reduce thanks to the effective adaptation as well as positive changes in the flood regime (it becomes less intensive). However, the impact on aquacultural production becomes more critical due to the negative changes of the "tieu man" flood regime (as summarized in table 6.2). The more intensive and longer duration the "tieu man" flood is, the more the death rate in the ponds is and the more aquacultural species are lost because they escape. As a result, aquacultural productivity has decreased significantly; sometimes the aquaculturalists even harvest nothing from their ponds. Thus, the income from aquaculture has considerable diminished. Do the aquaculturalists find new income generating activities to compensate for aquacultural income reduction? How do they diversify? These two questions will be answered in chapter 8.

In conclusion, the change of both the "tieu man" flood and the flood regime mainly causes the degradation of fish catch as well as aquacultural productivity. However, as argued by Bodley (2001 quoted in (Schipper, 2004), Klein (2002) and Nicholls et al. (2007), these impacts are not just caused by climate factors alone but also by non-climate ones. In case of the Tam Giang lagoon, this argument is reinforced by the literature (Tôn Thất Pháp et al (2002); IMOLA (2006); and Lê Văn Miên (2006). Their conclusion in particular holds true for the villages Phuoc Lap and Mai Duong - the study sites. What are the non-climatic factors contributing to the diminishing fish catch and degradation of aquacultural productivity degradation? The answers will be discussed in the next chapter.

CHAPTER 7: THE DECLINE IN FISHERIES AND AQUACULTURE - EXCLUSIVELY CAUSED BY CLIMATE CHANGE?

As discussed in chapter 2, the non-climatic stimuli also affect adaptation decisions of the people studied. Can different income strategies of fishers and aquaculturalists in the Tam Giang lagoon be explained as adaptations to climate change? In order to answer this overall research question, it is necessary to investigate what and how the non-climatic stimuli contribute to the impacts - degradation of fishery productivity. This chapter is divided into two sections - the first intended to discuss the degradation of the fish catch and the second for discussing the degradation of the aquacultural yields. Each of these sub-sections begins with the overview of how degradation occurs and then dissects the reasons of its manifestation. Timelines with turning points related to the most important extreme event were used to make this analysis.

7.1. Reasons for the decline of fish catch

The flood regime is perceived to change after the century flood in 1999. However, the trend in fish catch degradation, as showed in table 7.1, originated already around 1975. This indicates that there are other non-climatic factors causing the decline of fish catch. The fish catch is estimated by the fishers themselves based on some marine species that they usually capture. The average fish catch is the result of an addition of the highest fish catch and the lowest divided by two.

The year 1975 - the end of the Vietnam war - means a turning-point in many lives of Vietnamese. A number of demobilized soldiers chose fishing as their main livelihood. Besides, farmers also practiced fishing to improve their living. Therefore, the number of fishers over the lagoon increased. Moreover, some "modern" fishing gears made by synthetic fiber replaced traditional fish gears made mainly by bamboo. The "modern" fishing gears are sophisticated and efficient. However, they were not adopted as much in the lagoon. Only some "new" fishers (demobilized soldiers or farmers) applied these gears. The others did not apply these gears because these were new to them and the trade of these gears was not common (subsidized time[9]) and the fish catch was still high (as showed in table 7.1). As a result, the fish catch reduced only slightly compared to the year 1971.

"After liberation day (30th of April 1975), we only had to go around the lagoon 3 or 4 hours and we had our boats brimful of fish and shrimp. On average, each of us could capture around 100 kg fish and shrimp per day. This fish catch could exchange for about 200 kg rice which could provide us a comfortable life. At that time, crabs had no economic value; the people did not buy them for their meals. But they were caught in our nets; we had to take them out. We brought the biggest to our homes for our children; the remainders were released to the lagoon." - stated by the fishers in the focus group discussion (Phuoc Lap, 12/12/2009).

Ten year later in 1985, catches seriously began to decline when the number of fishers went up and more fishers started to use "modern" fishing gear. These developments reduced the fish catch by half.

By the 1990s, the demand of marine products for domestic as well as export markets increased considerably. As the economy and population grew under the "doi moi" policies, the price for fish increased sharply. The number of people fishing increased due to population development and also as an effect of the high incomes to be gained from the high price of fish. These

[9] This was the time that commodities were distributed by the State according to coupons and were not exchanged freely in the market.

processes of growth resulted in an increased competition between fishers. Fishers made most efforts to compete with others and to catch as much as possible. The overpopulation puts more pressure on lagoon resource and causes overexploitation (IMOLA, 2006). A number of different modern fishing gear was used. Especially, there was an increased use of electric fishing gear - wireless electric device. This kind of fishing gear can catch a large number of fish with relative little effort. However, it also destroys aquatic resources. Fish and shrimp whether big or small are killed by this gear. Some valuable and rare fish or shrimp such as *"thieu"* and *"moi"* fish (local name) disappeared. The reproduction can not compensate for this destructive exploitation. Correspondingly, the fish catch in 1999 was reduced by one third compared to the catch in 1975.

Table 7.1: Fish catch per day per household overtime (kg)

Year	1971	1975	1985	1999	2002	2007	2009
"The chan trang" shrimp	15	15	8	Rarely	0	0	0
"Chi" shrimp	15	15	10	6	4	1	0.5
Crab	50	50	30	10	1	0.5	0.3
Mullet fish	20	15	10	5	1	0.5	Rarely
Goby fish	15	10	10	5	4	2	1.5
"Thieu" fish	5	4	2	Disappear			
"Moi" fish	5	3	1	Disappear			

Source: Focus group discussion with the fishers

After the century flood in 1999, the destructive exploitation became more critical when another kind of electric fishing gear appeared - manual electric device. Moreover, the aquacultural area around the lagoon grows dramatically. Within four years from 1998 - 2001, the area increases by around 6 times. According to Lê Văn Miên (2006) and Lê Thị Nam Thuận (2010), the aquacultural area leaps from 579 ha in 1998 to 2930 ha in 2001 and 4287.44 ha in 2006. The grassplot zone existing around the lagoon shoreline, which provided reproductive ground as well as shelter for marine species, is completely turned into shrimp ponds. The development of aquaculture without planning destroys the habitat for marine species in the lagoon to reproduce and develop. Besides, fishing area of the fishers, especially of the mobile fishers is decreased considerably. In addition, due to the overpopulation as well the economic development, waste from residential areas, industrial clusters and agriculture leaked into the lagoon. The development of fixed fishing gears such as fish corral, bottom net in terms of quantity and type - using small mesh net – also prevent water circulation (IMOLA, 2006; Lê Văn Miên, 2006). The lagoon water environment degrades critically which impairs the growth ability of marine species. The concurrence of a number of reasons - fishers increase, destructive exploitation, aquacultural development and impacts of changing flood regime - causes a significant decline for fish catch. In 2002 the fishers only captured about one sixth of what they used to catch in 1975.

The chinese trap ("lu") appeared in 2006 and has become widespread since 2007. This kind of fishing gear can capture all sizes of fish and shrimp. Shrimp and fish which are as big as a pen nib can not escape from this Chinese trap. The destructive capacity of Chinese trap is comparable to electric fishing. In addition, the operation of the Thao Long dam which is used to reduce salinity in soils used for agriculture, also reduces the salinity level in the lagoon. The low salinity level leads to a reduction in biodiversity and impaired growth of marine species. However, since this dam is closed only a short time, the contribution of this dam to the degradation is ranked as less important. The increased use of the Chinese trap (lu) is the factor that aggravates a reduction in fish catch most seriously. The fish catch reduced critically – nowadays it is only one fifteenth (in 2007) and one thirtieth (in 2009) of the catches in 1975.

Table 7.2: The reasons of fish catch degradation

Order	Reasons	Contribution to the degradation
01	Excessive use of electric fishing gear	+++
02	Increased use of Chinese trap (lu)	+++
03	Development of shrimp ponds	++
04	Increased flood frequency	++
05	Increased number of fishers due to overpopulation	++
06	Water pollution due to increases of waste	++
07	Dam which prevents rise in salinity levels of agriculture	+

Source: In-depth interview and group discussion with the fishers

(Note: +++: very important; ++: important; +: less important)

The table 7.2 shows that a number of factors causing the decrease in fish catch. The changes of flood regime only contribute to a small portion in degrading fish catch. The greater impact comes from non-climatic stimuli, such as destructive exploitation, aquacultural development, overpopulation and infrastructural buildings. Using destructive fishing methods (fishing by electricity, small mesh net gears and Chinese trap) play an important role in the decrease. The degree of degradation is sped up dramatically when electric fishing gear and "lu" are practiced. The fishers participating in the group discussion were very angry and complained a lot about the impacts of destructive exploitation.

"The aquatic resources in the Tam Giang lagoon are destroyed mainly by destructive exploitation. If destructive exploitation is controlled, the decrease of fish catch will be stopped, fish catch will recover. Hence, our life will not be difficult as it is".

However, the fisher who practices Chinese trap (lu) said: *"I do not know whether or not "lu" harms aquatic resources in the lagoon. I only know that Chinese trap can bring to my family a comfortable life. Thousands of fishers practice Chinese traps in the lagoon. It is not only me."*

This statement implies a low awareness and unscrupulousness of a number of users over the lagoon and the weakness in management of the authority. According to Phuoc Lap village leader, there are 50 of the total 92 Phuoc Lap fisher households who practice Chinese trap with an average of 50 - 70 traps per household. In the other sites e.g. Huong Phong, Phu My and Vinh Giang commune more than 50% of the total fisher households practice this trap (Võ Ngọc Vũ & Hồ Lê Phi Khanh, 2010). The lagoon is open to everyone (Trương Văn Tuyển, 2002). Everybody can put their gears over the lagoon and collect fish and shrimp without permission. The development of destructive fishing gear such as wireless, manual electric device and Chinese trap (lu) can exist due to weak forms of management (Lê Văn Miên, 2006). The current laws as well as coercive regulation are not strong enough to stop and abolish destructive exploitation. It is difficult to control and prevent destructive exploitation when the awareness of the users is low and management is weak and inappropriate (Lê Văn Miên, 2006; Tống Thị Hải Hạnh & Lê Văn Nam, 2010). Under this management regime, coupled with impacts of global climate change, aquatic resources in the Tam Giang lagoon will be destroyed at higher speeds. Coastal ecosystem is degrading by the change of climate and coastal resource-use, that will be threats to the availability of fish (Campbell, 2008). Consequently, fish catch will continue to be reduced sharply.

7.2. Reasons for the decline of aquacultural productivity

Aquaculture began in 1994 by 5 farmers. At that time the knowledge and techniques used for aquaculture were not well developed, and consequently aquacultural productivity was very low (around 250 kg per 5000 m^2 per crop). With low investments and a high price for shrimps, people were able to obtain some profit. Step by step, the yields went up when knowledge, experiences as well as techniques for cultivation improved. The profit from aquaculture rose

significantly. The profit per 5000 m^2 of aquacultural crop (one crop per year) could be bigger than the profit earned from 5 to 10 years cultivating rice (two crops per year). These benefits attracted a number of farmers into aquaculture - from 5 farmers in 1994 to 132 in 1999.

In the beginning, the aquaculturalists cultivated crab, shrimp and fish in one pond. Shrimp breed was bought from breeding stations, while small fish and crab were bought from fishers. Because of huge profits to be earned from shrimp, the aquaculturalists since 1998 started to specialize in raising shrimp. They invested more money and labor into the shrimp ponds. Density of shrimp per m^2 climbed from 5-6 shrimps to 20-30. As a result, the quantity of shrimp food put in the pond increased dramatically. The productivity as well as profit grew continuously with a considerable rate. After the century flood in 1999, the cleaner lagoon water environment (as discussed in chapter 6), resulted in large profits in 2000 and 2001. The period from 1999 to 2001 was characterized as the "golden time" of aquaculture. The great profit encouraged aquaculturalists to put more money in their ponds. However, by 2002 the majority of aquaculturalists became penniless due to negative changes of the "tieu man" flood (as discussed in chapter 6). Hundreds of millions VND invested in the ponds were flushed away to the sea.

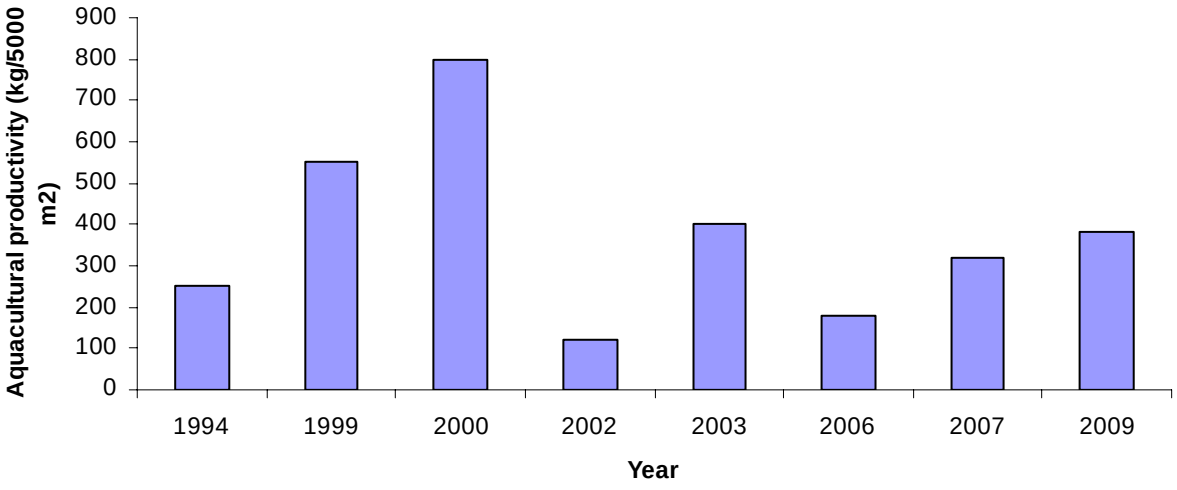


Figure 7.1: Aquacultural productivity[10] from 1994 to 2009 (Source: Focus group discussion with aquaculturalists)

The degradation of aquacultural productivity coincides with the changes of the *"tieu man"* flood. However, this coincidence does not mean that the changes of the *"tieu man"* flood regime completely cause the degradation. As summarized in table 7.3, the degradation is caused by a series of reasons originating from both climate and non-climate factors.

After 2002, the aquaculturalists used savings and loans (from banks and local lenders) to continue to cultivate shrimp. Their main purpose was to earn profit to compensate for the losses of previous years. However, the aquacultural productivity in 2003 was not good as expected. It decreased by a half compared to the yields in 2000 (see figure 7.1). The bottom of ponds had become polluted by the leftover of shrimp. The pollution is also a result of climate change (Nicholls *et al.*, 2007). The number of germs located in the bottom soil of the ponds can trigger dangerous diseases. Besides, the waste also pollutes the lagoon water. The water pollution and diseases impairs the shrimp growth ability and it also kills a number of shrimp. Although the productivity in 2003 was still higher than in 1994, the profit was not much in terms of both the number of aquaculturalist who get profit as well as the amount of profit per 5000 m^2 crop. This

[10] The aquacultural productivity was estimated by the aquaculturalists themselves related to the important events such as the year beginning of aquacultural; the year getting highest productivity and the year getting impacts of "Tieu man" flood.

situation originated from 3 main reasons. Firstly, the aquaculturalists invested a big amount of money but just collect small productivity. Secondly, a lot of money was spent to treat shrimp disease, and then the cost was bigger than in 1994. Thirdly, shrimp market price declined significantly - by one third.

Table 7.3: Aquacultural production in Mai Duong village

Year	Number of households practicing aquaculture	Profit percentage[11]	Breakeven percentage[12]	Loss percentage[13]
1994	5	100	0	0
1999	132	100	0	0
2000	132	100	0	0
2002	132	0	10	90
2003	132	60	15	25
2006	122	0	10	90
2007	120	20	45	35
2009	120	60	35	05

Source: Focus group discussion with aquaculturalists, 2009

After 2003, the aquaculturalists are confronted with several yield failures. The productivity as well as profit diminishes significantly. Apart from the change of the *"tieu man"* regime (as discussed in chapter 6), there are a number of reasons for these failures. Firstly, the pollution at the bottom of the ponds became critical when the aquaculturalists tried to put more food to get higher productivity. Secondly, the polluted level of lagoon water increased considerably, especially because of organic pollution (Nguyễn Văn Hợp *et al.*, 2005). As a result, dangerous diseases could easily spread. Thirdly, aquaculturalists bought low quality shrimp breeds. The number of shrimp ponds as well as aquaculturalists increased dramatically due to over-development of aquaculture. However, the good quality breeds produced by the small number of prestigious breeding farms were not enough to provide for a great number of aquaculturalists. Since there existed a high demand for breeds and a weak monitoring system, a number of illegal breeding stations started to produce low quality breeds and consequently sell at a cheap price (Lê Văn Miên, 2006). Because of continuous failure of aquaculture, the aquaculturalists did not have much money to buy the high quality breeds. They chose the cheap price - low quality breeds - to reduce costs. As a result, these low-quality breeds pushed the high-quality out of the market. The other stations who produce good quality breed could not compete and went bankrupt (Lê Văn Miên, 2006). Some of them also started to produce to the low quality breeds to survive while the others went broke. The aquaculturalists fell into a vicious circle. Because of bad breed, shrimp was infected easier by dangerous bacteria as well as virus. The situation in which shrimp died massively after breeding one or two months became a common phenomena. However, the aquaculturalists did not stop their crop. They spent money to buy chemical to treat germs and continue to breed shrimp fingerlings again. Within one crop, they put the fingerlings to the ponds at least three times (normally only one time). Unfortunately, these measures did not only cost a lot of money but also accelerated the development of the diseases. These events highlight the low skills and knowledge of the aquaculturalists (IMOLA, 2006; Lê Văn Miên, 2006). Correspondingly, the profit percentage declined to zero in 2006. On the contrary, loss percentage took off sharply - 90%. Notably, the losses - number of loss per 5000 m^2 was very high. On average, the aquaculturalists could lose more than 50 millions VND. These losses are the reason why many aquaculturalists now fail to pay back their debt to the banks and local lenders.

[11] The percentage of aquaculturalists households in Mai Duong village who get profit.
[12] The percentage of aquaculturalists households in Mai Duong village who get breakeven.
[13] The percentage of aquaculturalists households in Mai Duong village who get loss.

Table 7.4: The reasons of decline in aquacultural productivity

Order	Reasons	Contribution to the decline in productivity
01	Pond-bottom pollution produces dangerous diseases	+++
02	Over-investment (breed and shrimp food)	+++
03	Increasing of the *"tieu man"* flood intensity	+++
04	Bad shrimp breeds	++
05	Market fluctuations	++
06	Water pollution due to waste from residential areas and industrial clusters produces diseases and prevent the grow ability of fish and shrimp	++
07	Shrimp pond bank deteriorated due to floods from August to November	+

Source: In-depth interview and group discussion with the aquaculturalists
(Note: +++: very important; ++: important; +: less important)

In conclusion, the degradation of fishery productivity - fish catch and aquacultural productivity - is caused by a concurrence of both climate and non-climate factors. As discussed in chapter two, it is difficult to differentiate exactly what are the impacts of climate change or of non-climate factors. However, it seems that climate change impacts - changing flood regime impacts - contribute only a small portion to the degradation process. As Daw *et al* (2009) argue, the greater effect on fisheries belongs to non-climate factors such as overexploitation, overpopulation and weak management regime. But Daw *et al* (2009) emphasize that this argument is only appropriate in the short term. It can imply that in the long term the impacts of climate change can have a greater effect. If this hypothesis is true, how will the situation of the people who depend on fishery for their livelihood be in the future? Will they fall into poverty and starvation or survive and continue to develop? The next chapter argues that this depends much on their ability to diversify their income generating activities to cope and adapt to the degradation.

CHAPTER 8: INCOME DIVERSIFICATION AS ADAPTATION

The fishers and aquaculturalists are both facing fishery degradation, and then fishery income reduction. Do the fishers/aquaculturalists diversify their income generating activities to adapt to the changes/impacts? What are their different income strategies? What are other factors that enable or constrain income diversification and create income differences between fishers and aquaculturalists? This third sub-research question is answered in this chapter through two sections. The first section - section 8.1 - is intended to discuss the income diversification of the fishers and factors constraining them. The second, section 8.2 is considering the income diversification and constraining factors of the aquaculturalists.

8.1. Income diversification of fishers

Livestock

Since the fishers used small mesh nets in 1999 to catch fish, they caught a high number of small fish and shrimp which was not possible to sell or only against a very low price. Frequently these fishers raised livestock - ducks and chickens - which were fed on the small fish and shrimp and other household leftovers. On average, one household raised 5 to 6 ducks and 8 chickens per three months. The purpose of raising ducks and chickens was to improve the fishers' meals. When the mature ducks and chickens were slaughtered for food, the fishers bought new small ones to continue to raise. Poultry was not needed for cash because the income from fishing was still enough for fishers' expenditures even when the catch reduced to one third of the 1975 size. The fish catch reduction was compensated by the higher prices of fish and shrimp.

"Late in the 1990s, the demand of marine species for domestic consumer and export rose. A number of middlemen purchased marine species for export. They tried to compete to collect fish and shrimp as much as possible. Therefore, the price was twice as high compared to 1980s prices"- Fishers in the focus group discussion (Phuoc Lap village, 12/12/2009).

By 2002, ducks were raised for cash since fish catches reduced significantly to the point (1/6 share of the 1975 catch) where the income from fishing was not enough for food. Fishers intensified their livestock holdings. More than 20 ducks and 10 chickens per household were raised every three months. The fishers rarely ate the poultry themselves. They sold mature duck and chicken to the middlemen to get some more income for rice. The profit from raising duck and chicken was not much, but the fishers still practiced this activity since duck and chicken functioned as a "stored rice jar", i.e. a way of saving. When the fishers get less or nothing from fishing, they can sell duck or chicken to buy rice or medicine.

"My family just earns a little from the ducks and chickens. After selling all mature ducks (20), we got the total of around 600 thousand VND. About half of that money is used to cover the costs of duck food. The number of small captured fish and shrimp is not enough to feed ducks and chickens because nowadays the fish catch has been reduced. Instead I have to buy rice for them. The ducks grow slowly because we do not use appropriate raising techniques and we have no time to take care of them. Therefore, they eat more food than what is required. Anyhow, they can rescue us from starvation or illness." Mr. Quang - a 54 year old fisher

Unfortunately, the avian influenza (H_5N_1) spread among ducks and chickens in the end of 2004. All poultry was completely killed and the fishers suffered this loss. Despite this disaster, the fishers continue to raise poultry but on a smaller scale, about 5 - 6 ducks and 5 - 7 chickens per household, just enough to use the small fish, shrimp and leftovers.

Next to poultry fishers also started to raise pigs in 2002 to get more income. However, the fishers gave up this activity only after one year.

"I have never raised pigs before. I hear that some farmers in the neighbor villages can get some profits from feeding pigs. Income from fishing income is less than it was. Hence, I imitated them and bought rice to feed pigs. However, the two pigs grew very slowly, each of them weighs 35 kg after eating a lot of food in 6 month. One pig got a disease and died, the other one did not give me any profit." (Mr. Dan - a 49 year old fisher).

In 2006, the fishers nevertheless raised pigs again thanks to the promotion and support of NAV project. The project provided some training courses about pig raising and guided fishers in how to raise pig effectively. In addition, they supplied money for the fishers to make pigstys and buy pig breeds[14]. After these opportunities one household kept on average 2-4 pigs every 5 months. However, pig raising was stopped again by a dangerous disease - Porcine Respiratory and Reproductive Syndrome in early of 2008. Pigs infected by this disease were put to death by the veterinarians and authorities. The fishers suffered large losses again (on average one pig cost around one million VND). As a result, they now leave their pigpens empty.

Moreover, the NAV project also promoted other income activities such as rabbit raising, large scale chicken raising, eel raising and vegetable cultivation, to help fishers reduce their dependence on the lagoon resources. However, all of these activities failed. The fishers do not want to continue to adopt these activities after the second cropping because they can not get any profit when NAV project withdraw their support - both technique and finance. After the NAV project phased out, the productivity of these activities reduced by one third, while expenses increased. The fishers are not trained enough in raising techniques. Fishers are lucky because they can get supports from outsiders - NAV project. But, they can not grasp this opportunity because of low education.

"We participate in the training courses but we can not get knowledge for ourselves. The majority of us are illiterate therefore we can not write or take note of the important things in the class. We only hear what the trainers say. How can we remember what has been said only one time?" - explained by fishers in the focus group discussion (Phuoc Lap village, 12/12/2009).

Hired labor

The decline of the fish productivity forced the fishers, both men and women, to labor in their spare time to earn more money. The men loaded cargo such as rice packs, cement packs for the businessmen in the district centre and farmers. They earned 40 thousands VND per day (from 2002 to 2005). The income from these loading jobs was twice as high as the income from one fishing day during the flood season. However, there are not many opportunities to work as loader.

"Jobs as loader are hard to find, while there are many people who want them. The bosses want to employ only strong laborers, while our health is not good because we are old[15]. Therefore, they rarely employ us. In the flood season, we hope that someone calls us for working but it almost never happens." - explained by the fishers in the focus group discussion (Phuoc Lap village, 12/12/2009).

Because of the limited opportunities in loading jobs, the male fishers also look for jobs in construction. However, the construction businessmen also do not want to employ them since they think that fishers cannot do anything apart from fishing. Until 2006, thanks to funding of the

[14] The pig breeds were funded only one time, in 2006. On average, one households were funded around 1 millions VND to buy two small pigs. The donor did not ask for the return.

[15] According to Phuoc Lap village leaders, there are some young fisher households who under 40 years old - 5-8 households. However, the research only chose the fishers who have at least 15 years in fishing. Therefore, the young fishers were not opportunity to raise your ideas.

commune and some NGOs, Phuoc Lap contracted a construction businessman for building concrete road through the village. The households had to contribute the labor for this project. At that time, fishers' potential for construction works was recognized. The male fishers are hired by this construction businessman for a salary of 60-70 thousand VND per day. Nevertheless, the number of working days per month per fisher is not much, just 3-4 days. There are few businessmen employing them. For some old fishers (over 45 years old) these opportunities are not an option, since their health is not good enough to be employed in construction work.

Apart from men, the female fishers try to find jobs as rice planters as well as harvesters for farmers living in the commune. They also earn 40 thousand VND per day. However, farmers stopped to hire them after one or two rice crops.

"I was a sampan dweller before and have never cultivated rice or worked in the rice production. When income from fishing was not enough for my family, I asked the farmers for jobs in middle of 2002. They employed me to transplant rice with the salary of 40 thousand VND per day. I could get around 200 thousands VND for that crop. When the next crop came, I again asked them for transplanting work but they say no. I knew they did not hire me because I transplanted slow and not as well as the farmers themselves." - Mrs. Son.

These fishers want but cannot work. They try to find jobs to earn money but the labor market does not provide them many opportunities. Local prejudice, unskilled labor and bad health prevent them from earning money outside fishing. When I asked them why they do not go outside for jobs, they responded:

"The majority of our generation is illiterate. We were sampan dwellers. The living on boats did not permit us to go to school. Besides, when we were young we did not want to go because fishing provided us a comfortable life. We do not get any vocational training courses and do not have any skills. In addition, since we are old our health is not good. We need money but how can we get jobs outside under such situation if we migrate? Some farm owners in the high land region come to the commune and call for labors to harvest coffee. They employ a number of labors from August to around December, but they do not want us. Maybe they think that because we are fishers, we cannot do anything except fishing. The only thing left is to send our children who have been to school to the city for jobs."

Migration

Due to the low opportunities in livestock raising as well as hired labor, the fishers had to send their children outside the village for jobs. Girls were sent first to the better-off households in Hue city to become servants there. In 2002, there were about 10 girls leaving their home. These children had to drop out of school (secondary or high school) to help their parents overcome the difficult situation. They send back around 300 thousands VND per month to their parents. This was an important income which could rescue fisher households, especially the poor, from starvation. The migration of the first ten girls created an important relation with the employers to help others to migrate. The number of girls which migrate to the cities increased significantly. Apart from being employed as servants, they were employed in hairdressing shops. The boys were also hired to work for construction businessmen as well as candy enterprises or companies in the South - Ho Chi Minh City or in the Binh Duong industrial zone. Having low education and being unskilled, these children just do odd jobs. Consequently, the salary for them is not high - 1.5 to 2 million VND per month. During the discussions with fishers it became apparent that the current jobs of the children as well their salaries are not stable. Because they only do the odd jobs, they can be fired for any possible reason. These children scramble for a living in big cities. They have to ask for other jobs and accept any salary. Since the expenses in the city are high, they are not able to save much. As a result, some children can only send back to their parents about 5 millions VND per year for their family's rice while the others cannot. However, these children at least can feed themselves.

Moreover, the decline in fish catch in 2007 forced four poor fishermen to migrate during the flood season to earn some money. They were hired for fishing offshore by some fishers in the South region with the salary of 1.5 million VND per month on average. However, they decided to stay at home after migrating two times since the salary they get cannot compensate for their food and transportation costs.

"I am paid money according to the number of working days. But my working days are not much - 15 - 20 days per month. The time I am employed coincides with the time storms appear over the sea, hence sometimes boats are brought back to land for safety reasons. Sometimes I have nothing to do in a half of month while I have to spend money for food and accommodation. I just save a little but it is just enough to buy a bus ticket to come back home." - Mr. Don - a 52 year old fisher.

Table 8.1: Phuoc Lap demographic and migration situation

Year	Total of households	Total of heads	Migrants	Percentage of migrants
2004	135	758	35	4.6
2005	138	761	60	7.9
2006	144	780	120	15.4
2007	146	784	178	22.7
2008	149	788	230	29.2
2009	150	790	286	36.2

(Source: The statistics of Quang Phuoc commune)

The number of migrants increases dramatically (as showed in table 8.1). The majority of them are children under 18 years old. The more the fish catch declines, the more children migrate to the cities. The increase of migrants lessens to a certain degree the economic difficulty of fisher households.

"If these children do not migrate, the number of starved households in this village would even be higher. Besides, the migration can reduce the pressure on the lagoon resource." - Phuoc Lap village leader.

However, the fisher households as well as the authority have to pay a heavy price. The number of children dropping out school grows. This is an urgent social problem but it has not yet been addressed effectively.

"More than twenty children dropped out of secondary school to migrate at the beginning of this year (2010). The village authorities and their teachers come to their home more than two times to convince their parents to let them come back to school. However, they said to us that they have to send their children for money because they could not earn enough to feed them and send them to school. And if we want their children to come back to school, we should give them some money. What can you do in such a situation? We have to shut up and leave their homes." - Phuoc Lap village leader.

I brought this issue to discuss with the fishers through in-depth interviews. They almost all told the same stories.

"We do not want but we have to let our children migrate. But how can we send them to school when we even cannot get enough food for them? However, we intend to send them for a short time just to get enough food for the remaining children and to clear the debt in the difficult situation. After that we will invest some money for them to get vocational training to get stable jobs with a higher salary. Their current jobs are not stable. Sometimes they have to change their working place 3 or 4 time per year" - Mr. Quang who has 4 children out of 8 migrate to the city working as servants and candy wrappers.

When will these children get vocational training? This question cannot be answered in the near future when fish catches continue to decline and their parents cannot earn more money without fishing less. Low education coupled with unskilled labor - what possibilities exist for these children to look for a better life in the future?

Diversifying fishing gear

Fishing is a traditional livelihood activity of the fishers in Phuoc Lap village. Historically, the fishers were sampan dwellers who lived on boats. Fishers' families include more than 4 members living in harmony with the lagoon, only withdrawing lagoon resources for food. The fish catch not only provided them enough food but also brought wealth. Fishing was a sole income source for them to make a living. The fishers used rudimental fishing gear to catch fish and shrimp. One fisher family only used one type of fishing gear. However, when the fish catch from one type of fishing gear cannot provide enough income for their expenditures, the fishers start to use many types of fishing gear. The more the fish catch declines, the more types of fishing gear the fishers use.

The diversification of types of fishing gear becomes ineffective when fish catch continues to decline. As a result, in order to catch more fish the fishers diversify the size of net mesh. The mesh of nets now ranges from 7 to 30 mm instead of the 17 - 30 mm in older nets. The smaller net mesh gear have been used in Phuoc Lap village from the early 2000s. The fishers can earn some more money when they use smaller net mesh gears. However, these nets also further degrade the lagoon resources.

The diversification of gear types as well as size proves less effective when the lagoon productivity is critical degraded. Although the fishers use nets with small mesh, which have high capture capacity, they can not catch much fish. The fish catch per day in the dry season remains around 1 kg equivalent to 30 thousands VND. Sometimes they cannot even catch any fish. The fishers have to find another fishing activity as well as fishing gear to survive. At the end of 2006, a new fishing activity was practiced by a majority of Phuoc Lap's fishers - capturing shells by hand. This activity can provide 40 thousand VND per day for the fishers. However, they only get income from shell diving in the dry season.

"We have to swim underwater to capture shells. In the rain season, we do not dare to dive because the water pressure is high and the water streams very fast." - Mr. Don - a 52 year old fisher.

Besides diving for shells, the fishers also use another new fishing gear - the Chinese trap. This type of fishing gear is practiced by 8 fisher households in Phuoc Lap village in early 2007. At the end of 2009, this number increased by 40 and it continue to grow. The reason for this quick spread is simple:

"I can get a high income by using the Chinese trap. On average, I can earn from 60-80 thousand VND per day with 50 Chinese traps. Moreover, only a Chinese trap can catch fish in the inundation time."

As discussed in chapter 7, however, Chinese trap destructs small fish, shrimp and crab and thus dramatically degrades lagoon resources.

Because of the decline in fish catch coupled with insignificant income from livestock, hired labor and remittances, the fishers have to put greater effort to the lagoon to earn enough money for their family to survive. The increase in number and types of fishing activity as well as fishing gear correlates positively with the decrease of fishing catch. The more activities and more fishing gear types the fishers use, the more the fish declines. Diversifying income sources within fishing by using "high capture" fishing gears, can provide the fishers with more income than if they were specializing on one species. However, this action destructs the lagoon productivity in both

the short and long term. It can be considered a "wrong" strategy to compensate for fish catch reduction. The fishers will bear the negative results caused by their own actions. Fish catch declines and consequently income from fishing will reduce more and more.

Continuously "borrow" food, as a result

Borrowing money to buy rice or buying rice on credit was the early response of the fishers to cope with the decline in fish catch. The shortage of food usually occurs in the rainy/flood season. All the fisher households interviewed, whether ranked as the poor or middle, have to borrow money to buy rice or buy rice on credit. However, the debt is different among them. Conventionally, the poor have higher debts than the non-poor because they have more children to feed. Annually, the surplus income from fishing in the dry season was saved for food in fishing days off and other expenditures during the rainy/flood season. However, the fishers can not save anything since the early 2000s due to the decline in fish catch. They barely earn enough income to pay for their living in the dry season.

"When the rainy/flood season comes, the fish catch declines as well as the number of fishing days, which consequently reduces income. In addition, the saving from the dry season is not much. Therefore, we have not enough money to buy rice; we have to buy on credit. The total debt for rice is about 3 millions VND per year. If we borrow money we have to pay an interest of 3 % per month. If we buy on credit, we have to pay a higher price than normal. For example, if we pay money immediately - 40 thousand VND - we can get 5 kg rice but if we sign for debt, we just get 4 or 4.5 kg. But we have no choice. We have to wait for the remittance from our two children (out of 8 children) to pay this debt. Normally, we pay this debt at the end of lunar year - before Tet holiday. But sometimes we cannot pay." Mrs. Son – a poor fisher.

The degradation of fish catch not only causes food shortages but also lowers the living standard of the fishers. The expense for meals is the clearest proof hereof. When I visited Mr. Dan's house - a middle household - for an interview on the 18th of December 2009, his family was having lunch. Their meal was very poor. There was no protein food or vegetables. Five members sat around a rice cooker and a fish sauce bowl for their lunch. On average 10 to 15 days per month (in the flood/rain season) that fisher families have meals with only rice and fish sauce or salt (Cao Thị Hồng Nhung, 2008). Mr. Dan commented:

"If we get much from fishing, we will have some captured fish or sometimes pork for our meals. However, we cannot get much. We only earn around 1 million VND during this flood season - around 4 months. My two children have jobs in Ho Chi Minh City but they cannot help us. We cannot earn more money outside fishing because no one employs us. This small money cannot provide us enough rice, let alone nutritious food. Until now, we borrow from the local rich households 1.5 million VND. We have to save as much as possible to keep our debt from rising." Mr. Dan.

The fisher households try to diverse their income sources to overcome the difficult situation. However, the situation has not improved.

"We know that we will not survive if we depend much on fishing. We try our best to take other income sources but we can not." - fishers in the focus group discussion (Phuoc Lap village, 12/12/2009).

From 2002 until now, the fishers have borrowed money for food every flood season. Continuously borrowing food as way of surviving testifies of the low efficiency of other income generating activities and the low capacity of the fishers to get income outside fishing. Moreover, the borrowing food also indicates inability of the fishers in accessing to agricultural land.

"If we have rice field, we maybe would not take loan to buy rice and force our small children to migrate." - the fishers in the focus group discussion (Phuoc Lap village, 12/12/2009).Table 8.2: Responses of the fishers to confront with fish catch degradation

Year	1975	1985	1999	2002	2007
Level of decline of fish catch (compared to 1975)	1	1/2	1/3	1/6	1/15
Responses in Fishing	- Practiced one fishing gear type	- Practiced more than one fishing gear type	- Practiced more than on fishing gear type - Using many sizes of mesh net - smaller.	- Practiced more than on fishing gear type - Using many sizes of net – with smaller meshes.	- Practiced more t fishing gear type - Using many siz net – with smaller meshes. - Practice Chinese (lu) - Capture shell by
Livestock			- Raising duck, chicken (small scale)	- Raising duck, chicken (extended scale) - Raising pig (given up from 2003 until 2005)	- Raising duck, ch (small scale) - Raising pig
"Borrow" food				- Buy rice on credit/Take loan to buy rice in the flood season	Buy rice on credi loan to buy rice in flood season
Hired labor				- Loader (rarely) - Rice transplanting - Rice harvest	- Loader (rarely) - Construction (ra
Migration Permanent Temporary				- Servant	- Servant - Hired labor for hairdressing shop - Hired labor for restaurants - Hired labor for construction entrepreneurs - Wrap candy - Hired labor for f offshore in the So region

(Source: Focus group discussion and in-depth interview with the fishers)

8.2. Income diversification of aquaculturalists

Rice cultivation is the traditional livelihood activity for many generations of the people in the Mai Duong village. Individual households were allocated agricultural land for 20 years tenure in 1993 based on the decree 60-CP/1993. On average, each household member was allotted 500 m^2 land which was used for rice cultivation. The secure access to land created an incentive to increase rice production. People invested in fertilizer and used new rice varieties. As a result, rice yield increased significantly - from 150 to about 220 kg per 500 m^2. People used the surplus to keep livestock - mainly pigs. One household could sell 3 or 4 mature pigs every five months and get a profit of 400 thousands VND which equaled 200 kg rice. Besides, chickens and ducks were also raised but mainly for traditional ceremonies or improving private meals.

At the end of the 1980s, the Vietnamese government launched a policy to encourage people to begin aquacultural activities. In the beginning people in Mai Duong did want to start these activities, since aquaculture requires a large investment of more than 100 million VND. However, the profit obtained by outsiders changed people's mind. Several of them started to take a loan for building ponds to cultivate crabs, fish and shrimp. Some early yields brought them a profit of about 10 million VND per crop, which is equivalent to 5 tons of rice per 5000 m^2. These positive results triggered a growth of the number of aquaculturalists. Through the huge aquacultural profits, the income from rice cultivation and livestock had become less important. As a result the families involved in aquaculture concentrated all their labor on aquacultural production. They even employed labor for cultivating their rice fields or rented them out to others at 50 kg rice per 500 m^2 per crop and stopped keeping livestock.

Since the lagoon is easily accessible the aquaculturalists practiced fishing in their spare time to get some additional income. Since the aquaculturalists were not experts in fishing and fishing was not their main production, they did not invest much in vessels or gear. On average, the aquaculturalists caught around 1 kg fish and shrimp per day. The captured fish was usually used to supplement protein food for their own family. They continued fishing until 1994, when the increase in aquacultural ponds limited severely the access to the open lagoon water.

The development of aquaculture in terms of area, productivity and especially profit promoted a process of specialization. The aquaculturalists downsized almost all production activities which provided a small income and instead invested all their effort in aquaculture. They moved from diversification to specialization. All human and financal resources were reserved for aquaculture to get higher profits. However, this process started to reverse, i.e. from specialization to diversification, when the aquaculturalists were starting to get losses and yield failure.

Returning to self-cultivation and livestock again but not much

The initial high profits in aquaculture came to an end. Yield failures forced the aquaculturalists to return to rice cultivation to reduce expenses and get more income.

"Before we practiced aquaculture, rice cultivation kept us alive. However, this activity became insignificant when we got the large profits from aquaculture. Income per aquacultural yield equaled several incomes from rice yields. We did not want to cultivate rice but we could not let our rice fields lie fallow since they at least could provide us some food. Hence, we employed labors for cultivation. However, when aquaculture failed we had to come back to rice cultivation, doing it ourselves. We have to earn as much as possible to compensate for aquacultural losses. The hired labors never work our rice field better than us. If we cultivate by ourselves we can get the yield of 300 kg rice per 500 m^2 but if we employ people we just get 250 kg. By doing it ourselves we can save money." - Mr. Doan - a 52 year old aquaculturalist.

Although the aquaculturalists again invest efforts in the rice cultivation, they can not compensate for the aquacultural losses. The agricultural land area was distributed to the households in 1993.

Since then the household size has increase continuously, but no more land was distributed. In 1993, 500 m^2 rice kept one person per household alive, but now it had to keep alive 2 or 3 people. Besides, the rice cultivation also encountered difficulties produced from changed climate conditions and market changes. The abnormal occurrence and intensity of low extreme temperatures, the *"tieu man"* flood and drought diminished considerably the rice yields. It sometimes even completely failed. Furthermore, the price of fertilizer and other production materials increased, sometimes even doubled (from 2007). Although the commune provide rice breed and fertilizer for recovering rice production, this supports are not much and infrequent. The aquaculturalists only receive the supports including 5 kg rice and 2 kg fertilizer per 500 m^2 when they get significant damage (loss of more than 50% of the expected total). Therefore, it became difficult for the aquaculturalists to secure profits from rice cultivation. However, rice cultivation at least provided them with enough food (only rice) for their household subsistence need.

The aquaculturalists also repair and rebuilt the pigpens and started to keep livestock again. However, the operation scale was not big, only 4-5 pigs per household each 5 months. The aquaculturalists tried to expand these activities but could not do so because of lack of land. Land currently is used predominantly for shelter since the population increases. Each household has a living and cultivation area of around 100 m^2. The aquaculturalists have to reserve a small piece of their lot to raise pig. Since land is so scarce, they can only reserve 10 to 20 m^2 for the animals. These pigpens are often located in front of the gate of other houses. This location is the cause of many conflicts between households. The confined pig holdings pollute the environment, produce bad smells during the dry season and pollute the water in the rain season. These problems discourage the aquaculturalists to expand their livestock activities. Moreover, pigs are not so profitable because of the increased costs of fodder, and the losses caused by epidemic diseases. The aquaculturalists have to buy pig food because they have not enough surplus rice any longer. In addition, pigs frequently suffer from diseases due to their small confiding. This means that people are confronted with rising costs and diminishing prices. This situation becomes critical when a dangerous disease, the Porcine Respiratory and Reproductive Syndrome, occurs in early 2008. The aquaculturalists cannot rescue their pig because this is an untreatable disease. However, unlike the fishers, the aquaculturalists continue to keep a small number of pigs in the early of 2009 when this disease went away. Pigs are recognized as their savings. They put daily small money for pig food to their pigs. After that, they can accumulate a larger sum when they sell them to pay the debt and continue to invest for aquaculture.

"After getting massive yield failure in aquaculture and falling into debt, nobody lends me money. Last year (2009) I raised 6 pigs. I accumulated rather big money - around 10 millions VND when I sold all my pigs although I could not get any profit from them. I only take back what I spent. I used this money for repairing my shrimp pond which was damaged by the floods, buying crab, shrimp and fish breed and some food. I can obtain a little profit from aquaculture thanks to practicing mixed-culture. I hope that I can clear the debt soon. Therefore, this year (2010) I continue to raise 4 pigs for this yield and intend to raise 4 for the next. If there are no diseases, I will get back my money to reproduce aquaculture in the next year (2011)" - Mr. Khoi - a 53 years old aquaculturalist.

The aquaculturalists cultivate the rice fields by themselves and keep pigs again with the expectation that they can earn some to compensate for the yield failures in aquaculture. However, their expectation meets with difficulties. Rice cultivation and pig raising are also influenced negatively by the climate factors such as low temperature extreme and the *"tieu man"* flood as well as non-climate factors such as overpopulation, market fluctuations and diseases. These factors constrain the aquaculturalists from having a profit. The aquaculturalists can only recover their money if they are lucky.

Hired labor

Since 2003 aquaculturalists sell their labor to make up for the loss of their aquacultural yields. The husbands apply for jobs in construction where they can earn between 60-70 thousand VND per day. Not all aquaculturalist men work in construction since it is a tough job. Normally men work 20-22 days per month in the dry season. But this number reduces to 10-12 days in the rain season. The occurrence of floods prevents them from earning money.

"I have to work far from my home because my construction businessman usually contract with the people in the district centre - Sia town or the province centre - Hue city for building. In the flood season, I have stayed at home with no salary. I have no choice because the road is flooded." - Mr. Pho - a 43 years old aquaculturalist.

The other men who have not good health and women hire out their labor for agricultural work in and outside Mai Duong. They are employed to work the soil, put down seed, fertilizer or harvest rice with the payment of 50 thousands VND per day. However, the number of working days is not much, about 60 days per year because these are seasonal jobs. Sometimes they get some odd jobs such as tiled courtyards and cutting down bamboo trees.

The aquaculturalists can get some salary from hired labor, although job opportunities are limited, which thus restricts income generation of the aquaculturalists. However, the income which they can get mainly originates from the construction jobs and work in the rice cultivation.

"This commune and neighboring communes mainly depend on agriculture and fishery for a living. There are no trade villages, tourism, factories or industrial zones. Where are jobs? - Aquaculturalists in the focus group discussion.

Migration

The failure of aquaculture within two continuous years pushed the aquaculturalists to migrate permanently to the cities in the South region to look for jobs. The aquaculturalists send their children, who are over 18 years old and have finished school, to the cities to work for construction entrepreneurs, hairdressers or restaurant owners. They cannot migrate permanently themselves because they have to continue to take care of their rice fields, pigs as well as their ponds. In 2003, there were about 20 first migrants. The aquacultural households who suffered the highest loss were also those to let their children to migrate first. The number of migrants increased more and more when losses intensified. At the first time, these children only did odd and unstable jobs and hence received a low salary of 1.5 to 2 million VND per month. Therefore, these children could only send back a small amount money of 2-4 million VND per year. This amount cannot help their parents clear the debts. In order to get more money and stable jobs, the migrants start to work as apprentice. For example, if the migrant wants to become an apprentice to a hairdresser he or she has to pay some fee and work with no salary for their boss/teacher one or two years. The apprentice fee is often provided by their parents while food and shelter are provided by their bosses. Some migrants have to work hard for several years before being allowed to become apprentice, i.e. to have enough savings to pay the fee by themselves because their family is poor. The migrants can not get any salary in two years. However, their salary at least doubles and their jobs are more stable when they become skilled labors. The migrants sacrificed the small income in short time to get the high one in long term. This good experience is imparted to the people who intend to migrate in Mai Duong village. The aquaculturalists apprentice their children to local tailors, hairdressers or construction businessmen at cheaper fees before sending them to the South region. Therefore, the majority of migrants get jobs as worker in company, hairdressers or skilled labor in construction entrepreneurs and certainly high salary. In the end the remittances send home are much higher.

Moreover, the aquaculturalists have migrated to the Highland region from 2004 to work for coffee farm owners when local job opportunities in the flood season were limited. Within

households, it is the husband who migrates while the wives stay at home to take care of their children. They migrate when the rice and aquacultural yields are finished (middle of August) and return to their native village for rice cultivation and aquaculture as cropping time approaches (early of January of next the year). The coffee farm owners go to the village every year and ask people for work. The aquaculturalists are employed to harvest and take care (weed and put down fertilize) of coffee trees. The farm owners give them food and shelter and pay the salary which fluctuates from 1 to 2 million VND per month. This salary depends much on the coffee price on the market. If the owners can not sell their product at high price, the salary for the aquaculturalists will be reduced. However, this money anyway can help the aquaculturalists overcome their yield failures.

"We can earn some money instead of nothing in the flood season. I am employed for harvesting coffee from 2006. I can bring for my wife around 5-6 millions VND when I come back home. This money can help us reproduce aquaculture and rice cultivation when we can not take loan from banks or as local lenders." Mr. Trong - a 48 year old aquaculturalist.

Table 8.3: Mai Duong demographic and migration situation

Year	Total of households	Total heads	Migrants	Percentage of migrants
2004	253	1128	103	9,1
2005	258	1137	187	16,4
2006	263	1148	265	23,1
2007	267	1155	332	28,9
2008	217	1168	396	34,5
2009	276	1173	485	42,1

(Source: The statistics of Quang Phuoc commune)

Migration, both temporary and permanent, provides a significant income for the aquacultural households, which can compensate for the aquacultural yield failures. It is considered as the best strategy that helps aquaculturalists reduce their dependence on aquaculture as well as agriculture.

Practicing mixed-breed aquaculture

Though the aquaculturalists get so many failures in aquaculture, the majority of them do not want to leave it. They explained:

"We already put a great investment – more than 100 millions VND to make the shrimp ponds. The failures make us fall in debt of more than 50 millions VND. We have to continue to cultivate with the expectation that we will get some profit to clear the big debt and to regain our great investement. We can not leave them empty."

Due to the uninterrupted failures of monoculture, the aquaculturalists return to mixed systems (raising shrimp, fish and crab in one pond) from 2007. Besides, they also cut down the investments - by one fifth. The diversification of aquaculture improves the water environment in the ponds because it reduces the leftover. Aquacultural productivity also increases. Mixed-culture can reduce the loss percentage and increase the profit. The authorities as well as aquacultural experts encourage aquaculturalists to apply this culture through campaigns, training courses, demonstrations, and material supports. However, the profit rate is not much. Lê Văn Miên (2006), argues that the conversion of monoculture to mixed-culture is a step back of the Thua Thien Hue aquacultural sector. The aquaculture sector comes back to extensive - mixed aquaculture, instead of the identified process - from extensive to intensive aquaculture. Le Van Mien (2006) indicates that the step back of aquacultural also originates from the weakness in governance. There is an inappropriate development planning that guide the aquacultural sector to head in the right direction. Nevertheless, the aquaculturalists, authorities as well as aquacultural experts believe that this is the best solution to preserve finance and prevent future failure from environmental pollution and diseases.

"The profit from mixed-culture is smaller than from monoculture many times. Before we could get 50-100 million VND, but now it is only around 10-15 million. The profit is not enough for our expenditures such as paying the school fee, electric fee, health care ... let alone repayment of the loans. However, we can get a little from mixed-culture, which is better than nothing. The mixed-culture can lessen the pollution in the pond; hence germs have little "opportunities" to boom. Besides, since crab, shrimp and fish can not get the same diseases, we can at least harvest some." - aquaculturalists in the focus group discussion (Mai Duong village, 12/24/2009).

Apart from aquacultural epidemic diseases the aquaculturalists get more damages due to the change of the *"tieu man"* flood regime. Fish, named *Kinh*, which was normally raised is very sensitive to low salinity level. When floods or heavy rain water comes to the ponds, this kind of fish is killed immediately. The aquaculturalists replace *Kinh* fish by *Dia* fish which can stand fresh water. However, this replacement has not been successful, since consumers prefer *Kinh* fish. Not only is it more difficult to obtain high prices for *Dia*, the costs of breeding Dia is also higher. As a result, the aquaculturalists keep on breeding Kinh against the high risks. They are waiting for the researchers who can find a "new appropriate fish" as well as authorities who can build the dam to prevent the *"tieu man"* flood damage.

Diversifying within aquaculture improves the efficiency, reduces losses and brings again some profit to the aquaculturalists. However, this strategy can not help the aquaculturalists overcome and reduce the impacts caused by the change of *"tieu man"* flood regime.

Looking forward to the future by investing for education to get good jobs

The uninterrupted failure of aquaculture changed the aquaculturalists' state of mind. They no longer believe that they can get huge profits from aquaculture equivalent of those experienced during the "golden time". As the aquaculturalists put it:

"We will not survive and develop if we depend mainly on aquaculture."

Apart from diversifying income generating activities to compensate for aquaculture, the interviewed aquacultural households, including both the poor and middle-incomes, try to invest for their children to go to school or take vocational training. They do not want to let the younger generation to practice aquaculture. The aquaculturalists believe high education and high skilled labor will help their children to escape from aquaculture and get good jobs.

"I have 4 children. The first child studies in the University of Hue economic, the second works for a local construction businessman to get apprentice and the two last are on secondary school. I encourage and create rather comfortable condition for my children to go to school even if my family is poor. I expect that all of my children can get a high degree in education to become government or company officers. But whether my expectation becomes true or not depends much on the will of my children. My second child dropped out high school last year. He did not want to learn because he always gets bad grades and he wants to migrate to the South to earn money. I and my husband have to force him to stay at home and send him to the local construction businessmen to become a skilled labor. I hope that the two last will not imitate their older bother." - Mrs. Ngo - a 43 year old aquaculturalist.

Both fishers as well as aquaculturalists diversify their income sources to compensate for the income reduction in fishing and aquaculture caused by environmental degradation. The diversification can be divided into two types - diversification within fishery and diversification outside fishery. Within fishery, the fishers try to diversify the type of gear and its design (mesh size) of fishing gear while the aquaculturalists diversify the species that they breed. Diversification outside fishery includes keeping livestock, working as laborers and migrating, which are practiced by both fishers and aquaculturalists. Moreover, the aquaculturalists have the possibility to add rice cultivation to this list. The access to agricultural land can secure the aquaculturalists of their needs of food. Access to land is the main difference in this respect

between fishers and aquaculturalists and creates the inequality between them. The diversification outside fisheries that these groups pursue is obstructed by the occurrence of unfavorable climate condition, epidemic disease (Avian Influenza and Porcine Respiratory and Reproductive Syndrome) and the absence of a local labor market. More important, job opportunities outside fishery are limited for both groups. The labor market has only limited employment alternatives in the coastal regions and is therefore considered as the most important barrier for altering the livelihood of fisheries sector (Willing, 2007). Besides, the fisher's income diversification is impeded by the local prejudice, their low education and unskilled labor. To a certain extent, the fishers as well as aquaculturalists manage to get some income from outside fishery for their living. However, does income diversification of the fishers/aquaculturalists qualify as adaptation to climate change? This fourth sub-research question will be answered in the following chapter - chapter 9.

Table 8.4: Responses of the aquaculturalists to confront with aquacultural productivity degradation

Year	Before 1994	1994	1999	2000	2002	2003	2006	2007	2009
Profit/loss		profit	profit	profit	completely loss	a little profit	critical loss	a little profit	a little profit
Responses Rice cultivation	- Self - cultivation	- Self - cultivation	- Hired labor - Rent land	- Hired labor - Rent land	- Hired labor - Rent land	- Self - cultivation	- Self – cultivation	- Self - cultivation	- Self - cultivation
Fishing	- Practice gill net	- Practice gill net							
Livestock	- Duck, chicken - Pig	- Duck, chicken - Pig				- Duck, chicken - Pig	- Duck, chicken - Pig	- Duck, chicken - Pig	- Duck, chicken - Pig
Aquaculture		- Mixed-culture	- Mono-culture	- Mono-culture	- Mono-culture	- Mono-culture	- Mono-culture	- Mixed-culture	- Mixed-culture
Hired labor						- Construction - Rice cultivation	- Construction - Rice cultivation	- Construction - Rice cultivation	- Construction - Rice cultivation
Migration Permanent						- Hired labor for hairdressing shops - Hired labor for restaurants - Hired labor for	- Worker - Hired labor for hairdressing shops - Hired labor for restaurants - Hired labor	- Worker - Hairdresser - Skilled labor in construction entrepreneur - Hired labor for construction	- Worker - Hairdresser - Skill labor in construction entrepreneur - Hired labor for construction

Temporary						construction entrepreneur	for construction entrepreneur Harvest coffee in the High land region	entrepreneur Harvest coffee in the High land region	entrepreneur Harvest coffee in the High land region

CHAPTER 9: ANALYSIS - DIFFERENCES BETWEEN ADAPTATION AND MALADAPTATION

The decline in fishery dramatically lowers the income of fishers and aquaculturalists. Income from fishery cannot provide the basic subsistence needs of fishers or aquaculturalists. This means that they are forced to take action in response to the degradation of lagoon resources. As mentioned in chapter 6 and 7, this degradation is caused by both climatic and non-climatic factors. Income diversification is the most common way to adapt. This thesis has shown that climate change is one factor among a number of others which triggers adaptation (see also Adger *et al.*, 2005; Agrawal, 2008; Füssel, 2007; Klein, 2003; Klein & Tol, 1997; Pouliotte *et al.*, 2009; Smit *et al.*, 2001; Smith *et al.*, 2000; Smithers & Smit, 1997)

The discussion in chapter 8 highlights two differences between the fishers and aquaculturalists when they diversify their income sources outside fishery. The income diversification of the aquaculturalists can be explained as a process of adaptation. The aquaculturalists overcome a difficult situation: income reduction caused by aquacultural yield failures. Although not much compensation can be gained from rice cultivation or keeping livestock, they manage to obtain compensation through working as laborers and through migration. The income from jobs outside the fisheries, especially from permanent and temporary migration, can help aquacultural households to lessen their dependence on lagoon resources in the long term. Migration and remittances are important factors which contribute to the social resilience of the coastal communities in Vietnam, in particular those having to deal with extreme events (Adger *et al.*, 2003; McLeman & Smit, 2006). On average, one aquacultural household has 6 members, of which two are permanent migrants. The permanent aquacultural migrants almost always are working as skilled labors. They are able to get stable, long-term and well-paid salary jobs in the cities. Moreover, the success in migration inspires aquacultural households to invest in education and vocational training for their small children, which can offer them a way out of aquaculture and agriculture.

Conversely, the fishers almost all fail when they try to earn an income outside fishing. The fishers have limited job opportunities. Moreover, keeping livestock has not been able to bring any profits. This leaves only migration open as option to provide them some income for food. However, migration cannot be considered as an adaptation process. The majority of migrants from fishers' families are children who have dropped out of school (mainly secondary school) in order to migrate. They lack not only education but also labor skills. The low education and especially unskilled labor which these children perform prevents them from getting stable and well-paid jobs. The fishers understand this problem but they are not able to solve it. The shortage of food and finances does not permit them to prioritize the education and vocational training for their children. In the current situation the migrants from fishers' families do lessen the burden of their family by feeding themselves and sending home some remittances. Still, this situation can easily degenerate; they may easily become unemployed. The literature does not qualify this kind of migration as adaptation (Burton *et al*. 1993 as quoted in Smithers & Smit, 1997, p. 134). Dropping out of school for migration makes the fishers' households more vulnerable in the long term. This action is thus "wrong" adaptation or "maladaptation" (Burton 1996, as quoted in Grothmann & Patt, 2005; Klein & Maciver, 1999). However, this situation can change in a positive way in the future. It depends whether or not the fisher migrants can be trained to become skilled labors.

Since generating income outside fishing is difficult for the fishers they remain highly dependent on the lagoon resources. They diversify their fishing gear in terms of type and size to catch as much fish as possible. Coulthard (2008) argues that diversification of fishing gear is an adaptation of the Dhonirevu fishermen in Pulicat lagoon to reduce the impacts of climate change.

However, the context of Tam Giang lagoon counters her argument. The Tam Giang lagoon resources which form the foundation for their livelihood are destructed in this process of diversification and increase the vulnerability of fishers. So here too, income diversification within fishery can be labeled as a form of maladaptation. Income diversification within aquaculture can contrarily be considered as adaptation. The diversification of the sorts of species that they breed in the ponds can reduce environmental pollution and yield losses. The profit from aquaculture now takes an upturn. The aquaculturalists earn some more money from diversification.

Grothmann and Patt (2005) emphasize the importance of risk perception and perceived adaptive capacity and argue that high risk perception associated with high perceived adaptive capacity produces adaptation, while high risk perception associated with low perceived adaptive capacity produce maladaptation. This argument can be used to show that both the fishers as well as aquaculturalists have a high risk perception as well as high perceived adaptive capacity. Both of them understand that they will not survive if they depend completely on fishery for their living. They diversify their income sources and take action to diversify, but with different outcomes.

The case study of the fishers in Tam Giang lagoon illustrates the critical role of adaptive capacity determinants for determining the outcomes of processes of adaptation. The difference in education, skill labor and access to agricultural land creates the difference between the fishers and aquaculturalists, and the difference between adaptation and maladaptation. The fishers are trapped into a vicious circle and need a hand to pull them out.

Conventionally, income diversification is recognized as an effective way to spread risk and to manage the uncertainty and the impacts of change (Ellis, 2000). Coulthard (2008) believes that income diversification, both in and outside artisanal fishing of the Dhonirevu fishermen in the Pulicat lagoon (India), is a form of adaptation to the impacts of climate change. This thesis has provided counter evidence against this argument. It has analyzed the success and sustainability of income diversification strategies of the fishers in Tam Giang lagoon and proves that this case can be an exception to these arguments. The case study indicates that income diversification not always can be considered as an adaptation process. Income diversification is indeed a way for fishers to adapt to changes. However, it cannot be identified as adaptation because the outcomes are unsuccessful and unsustainable. The difference in argument between the Tam Giang lagoon case and the Pulicat lagoon case stems from a different usage of the concept of adaptation. Coulthard (2008) does not analyse how successful and sustainable these adaptation strategies are, but still makes the argument that income diversification should be considered as adaptation. The Tam Giang lagoon case implies that success as well as sustainability needs to be included into the understanding of adaptation. Adaptation should be defined as a *successful and sustainable* adjustment to alleviate the negative impacts of change.

The income diversification of fishers and aquaculturalists is a rather autonomous process which occurs without much external intervention. It seems that the Government, i.e. the commune authorities, until now does not intervene to help the people alter their dependence on the lagoon resources. The commune authorities have usually intervened twice to help their residents adapt to floods. Firstly, they campaigned for the consolidation of housing and tried to save lives by moving people to high and safe places. Secondly, they delivered the food relief received from the State, NGOs and some private donors, to people in or after the inundation time to rescue them from immediate starvation. Sometimes, they support rice seed and fertilizer to the aquaculturalists to recover from damaged crops. The losses of fishing and aquaculture are almost disregarded. More attention is put on the losses of rice production which is exclusive to the aquaculturalists and also impacted significantly by climate change. No interventions are made for the facilitation of livelihood alternatives. The absence of local labor markets is the clearest evidence hereof. Fishers received intervention from the NAV project to diversify their income sources. However, this kind of intervention does not solve the underlying problem of the

illiteracy, low education and unskilled labor, which prevent fishers from becoming less dependent on lagoon resources.

CHAPTER 10: CONCLUSION

Climate conditions play an important role in the livelihood of natural resource dependent people. The fish catch as well as the aquacultural yields obtained by fishers and aquaculturalists in the Tam Giang lagoon depend significantly on the floods: the *"tieu man"* flood occurring in the dry season (from February to early of August); and floods occurring in the rainy season (from middle of August to late of January). The results of this participatory study show how the flood regime has changed. The *"tieu man"* flood has increased in terms of intensity and duration. The floods during the rainy season are reduced in intensity, but have increased in frequency and duration. Both the *"tieu man"* flood and rainy season floods have become less predictable.

The change of the flood regime alters its impacts on the livelihoods of fishers and aquaculturalists. Loss of houses, property and lives has become relatively small for these livelihoods compared to the reduction of the lagoon productivity. The higher frequency of floods causes a decline of lagoon resources and number of fishing days. The higher intensity and longer duration of the *"tieu man"* flood causes a massive die-off of the species bred in aquaculture (shrimp, fish and crab). These species die because of the high pollution in the water or from the massive inflow of fresh water. Furthermore, the floods also enable these species to migrate from ponds into the lagoon. The higher frequency as well as longer duration of rainy season floods sweep away marine species, fish and shrimp, into the sea and as a consequence negatively influences the biodiversity in the lagoon. Moreover, these floods also reduce the number of fishing days. Because of artisanal fishing, the fishers in Tam Giang lagoon cannot go to capture fish under the situation of strong wind and waves caused by floods. However, the decline of lagoon productivity is also a result of other non-climatic factors. The distinction between the impacts of climate change, i.e. flood regime change, and of non-climatic factors, overpopulation, overexploitation and environment pollution, is impossible to make. Nevertheless, the contribution of non-climate factors to the lagoon productivity reduction is substantial. The coming together of impacts of climate and non-climate factors diminishes the income of the fishers and aquaculturalists, who mainly depend on lagoon resource for a living. Fishing and aquaculture no longer provide enough income for their food and other subsistence requirements. Action to counter income reduction is urgently needed in order for families to survive and develop in the future.

The fishers as well as aquaculturalists diversify their income source to adapt to the income reduction, which is partly caused by climate and non-climate factors. Climate change is among the stimuli to which adaptation strategies are made. Diversification is tried both within and outside the fisheries. Within fisheries, people diversify the types as well as design (mesh size) of fishing gear in order to catch as much fish as possible. The aquaculturalists diversify the species that they breed - shrimp, fish and crab instead of only shrimp - to reduce losses. Outside fisheries, both the fishers and aquaculturalists started to keep livestock, work as hired laborers and migrate to earn money to compensate for the income reduction. Moreover, the aquaculturalists can acquire food thanks to the allocated rice land, which they obtained in 1993. The unfavorable climate conditions, epidemic diseases and absence of local labor market prevent both groups from a further diversification of income.

The results of the study also show that the aquaculturalists have more capacity (in terms of social capital, education and access to rice land) to adapt than the fishers. The income diversification of the fishers is explained in this thesis as a form of maladaptation. The income diversification pursued by the fishers, whether in or outside fisheries, only helps them to cope with their current adverse situation. Their diversification can mitigate this adverse situation in the short term, but will get them into a more vulnerable situation in the long term. Income diversification of the aquaculturalists is seen as a form of adaptation. The aquaculturalists can reduce their dependence

on aquaculture in the long term thanks to income from hired labor, permanent and temporary migration. To sum up, local prejudice, low education, unskilled labor and inaccessibility to rice land are the key factors that impinge upon the adaptive capacity of the fishers.

Moreover, the empirical findings infer that in order to understand adaptation, researchers need to consider how the success and sustainability of adaptation strategies are. Adaptation should be defined as a *successful and sustainable* adjustment to alleviate the negative impacts of change.

Income diversification strategies of the fishers as well as aquaculturalists in the Tam Giang lagoon can be considered as reactive and autonomous processes, which occur without government intervention. Among stimuli forcing the people to adapt and to diversify their income sources, non-climate factors - development stresses such as overexploitation, weakness in natural resource management, overpopulation and environmental pollution - play a critical role. It is obvious that the key constraining factors of income diversification, such as local underemployment, low education and unskilled labor, are all critically related to these non-climatic stimuli. In order to facilitate adaptation instead of maladaptation, policies - intervention of the Government and NGOs - need to address the interrelation between climatic and non-climatic factors. Integrating climate change adaptation into more conventional development issues such as livelihood enhancement, environmental management and sustainable development can possibly create effective means to improve the adaptive capacity of the people in the Tam Giang Lagoon (see also Huq *et al.*, 2003; Smit & Wandel, 2006)

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